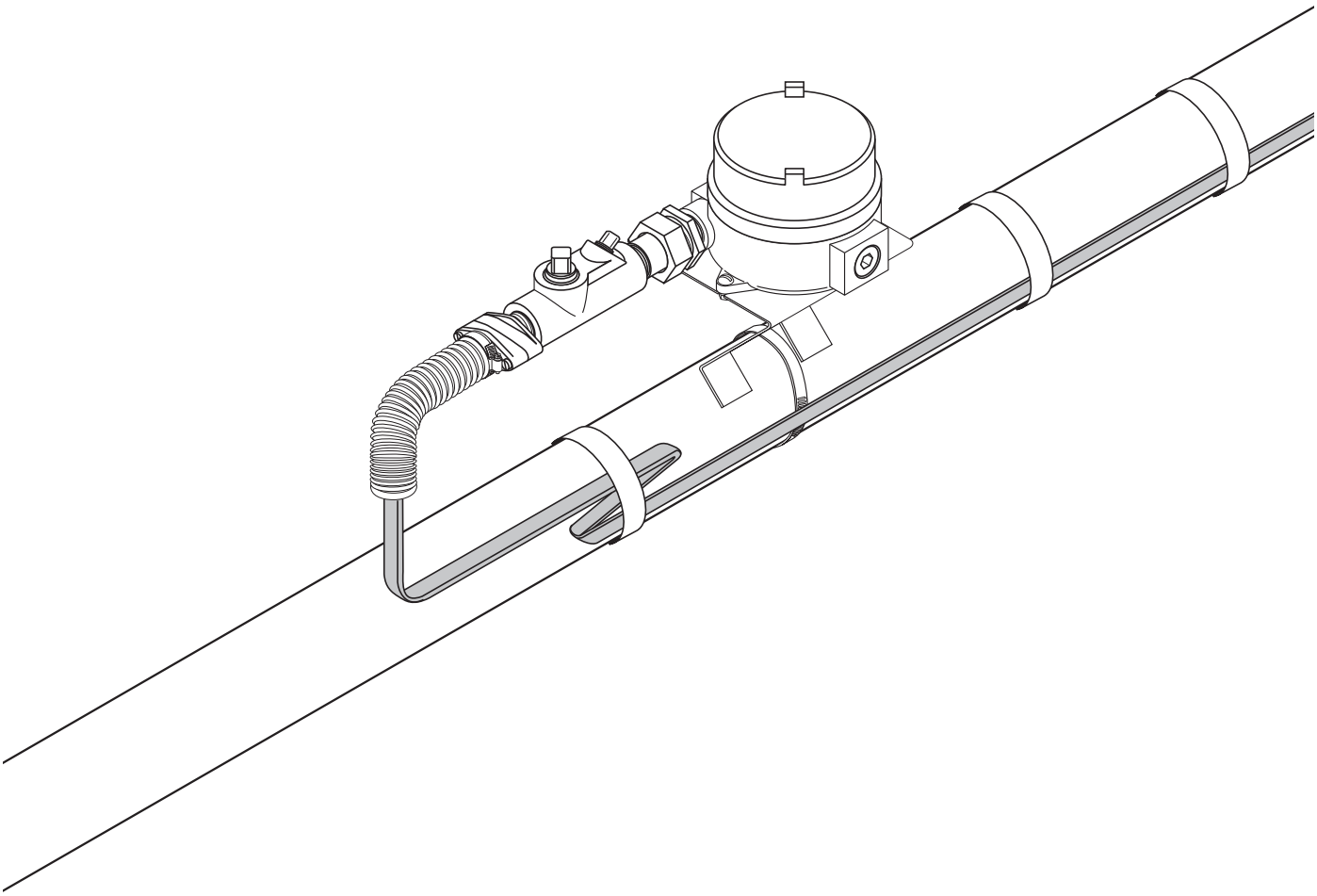
Heat-Tracing Systems

nVent RAYCHEM

FOR HAZARDOUS DIVISION 1 LOCATIONS DESIGN AND INSTALLATION GUIDE



Heat-Tracing Systems for Hazardous Division 1 Locations

Raychem-DG-H56075-HTSystemsForHazDiv1Loc-EN-1805

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Heat-Tracing Systems for Hazardous Division 1 Locations

Important Safeguards and Warnings

⚠ WARNING: FIRE AND SHOCK HAZARD.

nVent RAYCHEM heat-tracing systems must be installed correctly to ensure proper operation and to prevent shock and fire. Read these important warnings and carefully follow all the installation instructions.

- **To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with nVent requirements, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit breakers.**
- **Approvals and performance of the heat-tracing systems are based on the use of nVent specified parts only. Do not substitute parts or use vinyl electrical tape.**
- **Bus wires will short if they contact each other. Keep bus wires separated.**
- **Components and cable ends must be kept dry before and during installation.**
- **The black heating cable core and fibers are conductive and can short. They must be properly insulated and kept dry.**
- **Damaged bus wires can overheat or short. Do not break bus wire strands when preparing the cable for connection.**
- **Damaged heating cable can cause electrical arcing or fire. Do not use metal attachments such as pipe straps or tie wire. Use only RAYCHEM approved tapes and cable ties to secure the cable to the pipe.**
- **Do not attempt to repair or energize damaged cable. Remove damaged cable at once and replace with a new length using the appropriate RAYCHEM splice kit. Replace damaged components.**
- **Re-use of the grommets, or use of the wrong grommet, can cause leaks, cracked components, shock, or fire. Be sure the type of grommet is correct for the heating cable being installed. Use a new grommet whenever the cable has been pulled out of the component.**
- **Use only fire-resistant insulation which is compatible with the application and the maximum exposure temperature of the system to be traced.**
- **To prevent fire or explosion in hazardous locations, verify that the maximum sheath temperature of the heating cable is below the auto-ignition temperature of the gases in the area. For further information, see the design documentation.**
- **Material Safety Data Sheets (MSDSs) are available on-line at nVent.com.**

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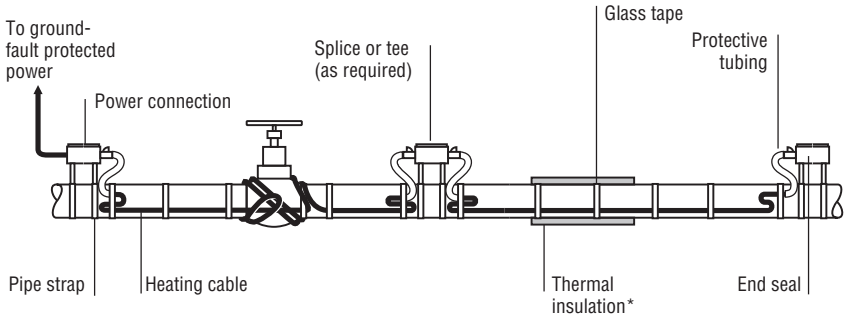
Introduction

1.1 Scope

This guide applies to RAYCHEM heat-tracing systems covered by FM Approvals (FM) or CSA Group (CSA) Certification for Division 1 hazardous locations. These applications are defined in part by the National Fire Protection Association (NFPA) 70, National Electrical Code (NEC) Article 500, and the Canadian Electrical Code (CEC) Part I, Section 18.

1.2 Typical System with Components

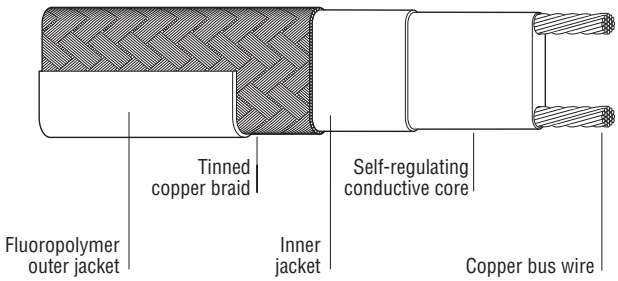


*Thermal insulation is required on all heat-traced pipe.

1.3 Division 1 Heat-Tracing Cables

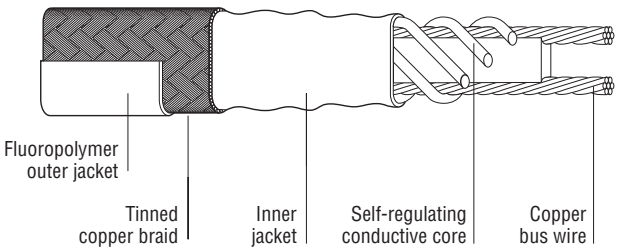
nVent offers solid-core and fiber-wrapped heating cables for Division 1 areas as shown below.

The design sections of this guide will help determine the heating cable best suited for your application. Table 1 in Section 2.0, Thermal Design, gives the performance data for these heating cables. All system components are specifically designed and approved for Division 1 applications. No parts can be substituted or omitted.



FM Approved HBTV-CT and HQTV-CT Heating Cables

CSA Certified BTV-CT and QTVR-CT Heating Cables



FM Approved HXTV-CT Heating Cables

CSA Certified XTV-CT Heating Cables

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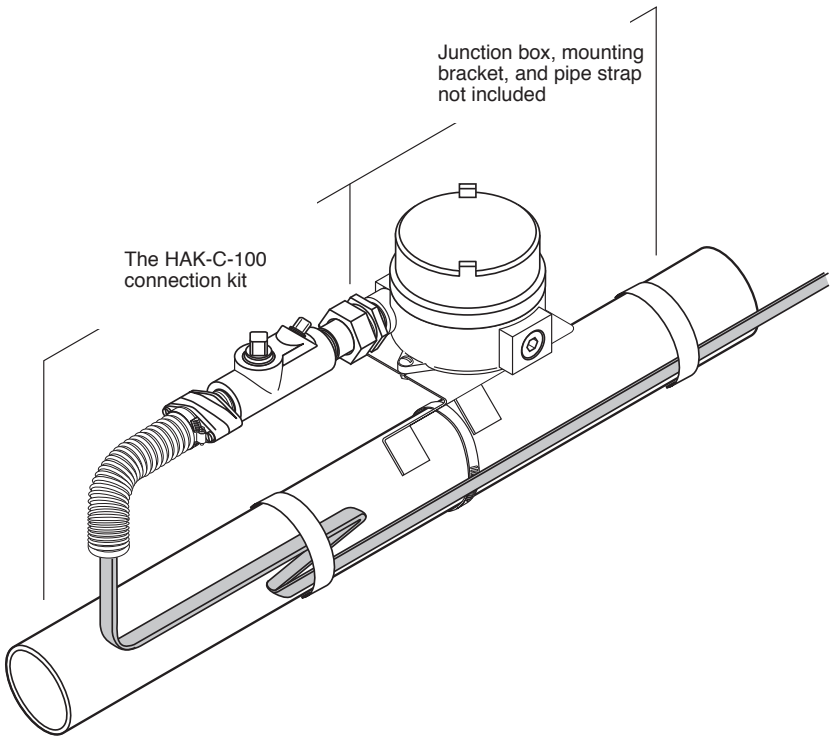
1.4 Electrical Connections and Components

The HAK-C-100 connection kit is FM Approved and CSA Certified. The kit must be used for all power connections, splices, tees, and end seals in Division 1 locations.



If components are installed in a Division 2 or ordinary area, other RAYCHEM industrial connection systems can be used with the approved Division 1 heating cable.

Note: In addition to the nVent RAYCHEM HAK-C-100 connection kit, junction boxes, pipe straps, and mounting brackets must be ordered. Additional HAK-C-100 kits are needed for splices and tees. (Splices require one junction box and two HAK-C-100 kits; tees require one junction box and three HAK-C-100 kits.) See Section 4.0 for a complete component assembly matrix and catalog numbers.

1.5 Electrical Protection

⚠ **WARNING:** To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with nVent requirements, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit breakers.

⚠ **WARNING:** Disconnect all power before making connections to the heating cable.

nVent, the NEC, the CEC, FM, and CSA require ground-fault protection of equipment for all Division 1 locations to reduce the risk of fire caused by damage or improper installation.

These devices are commonly available with 30-mA trip levels and are rated up to 30 A for 120, 208, and single-phase 240 Vac grounded systems.

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Thermal Design

2.1 Introduction

This design section covers the selection process for both FM Approved and CSA Certified systems. There are different steps required, depending on which approval agency is desired.

2.2 Special Requirements

⚠ **WARNING:** Fire and shock hazard. This electrical system must be designed and installed properly. To prevent fire or electrical hazard, follow all warnings and instructions in this guide and all literature included in product packages.

Due to the potentially hazardous nature of Division 1 locations, these requirements must be followed at all times.

For FM Approved systems

- Use only nVent RAYCHEM HBTV-CT, HQTV-CT, and HXTV-CT heating cables and RAYCHEM HAK-C-100 components specifically approved by FM. Do not substitute any parts.
- Use ground-fault equipment protection devices.
- Send field information from Appendix E to the nVent Customer Service Center for design verification.
- Complete the Division 1 Installation Record in Appendix F. Installers are required to complete and submit a Division 1 Installation Record to the RAYCHEM Customer Service Center.

For CSA Certified systems

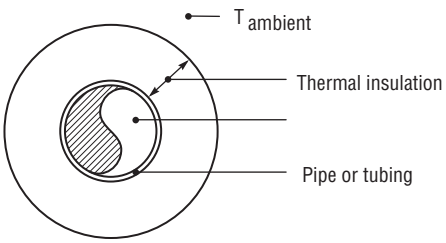
- Use only nVent RAYCHEM BTV-CT, QTVR-CT, and XTV-CT heating cables and HAK-C-100 components specifically certified by CSA. Do not substitute any parts.

2.3 Heating Cable Selection

To determine the heating cable catalog number, you must know:

- T_M: desired maintenance temperature (°F)
- T_A: minimum expected ambient temperature (°F)
- Continuous exposure temperature (°F)
- Pipe or tubing size
- Thermal insulation type and thickness
- Service voltage
- Approval required (FM or CSA)
- T-rating of the area or the lowest auto-ignition temperature (AIT), expressed in °C, in the area of use.

The following steps in this section describe how to determine this information.



Note: All thermal and electrical design information provided is based upon a standard installation: heating cable fastened with glass tape to an insulated metal pipe. The appendices in this guide are provided to assist you in calculating alternative installation methods. Consult your nVent representative for design assistance, if needed.

Heat-Tracing Systems for Hazardous Division 1 Locations

Step 1: Collect the thermal design application information:

Example:

- T_M: 40°F (4.4°C) [water freeze protection]
- T_A: –20°F (-28.9°C)
- Maximum continuous exposure temperature: 100°F (37.8°C)
- Pipe or tubing size: 6" steel
- Thermal insulation type and thickness: 2" calcium silicate
- Service voltage: 240 V
- Approval required (FM or CSA): FM
- Material with the lowest AIT, expressed in °C, in the hazardous area: Benzene, AIT = 498°C

Note: Publication NFPA 325 gives ignition temperatures for many hazardous materials.

Step 2. Determine the T-rating requirement:

Note: Keep all records of T-rating determination. The nVent Customer Service Center will ask for this information to fill orders. This information must be recorded in Appendix E and sent to nVent.

If the T-rating of the area has been defined, then select a heating cable from Table 1 (page 10) having a T-rating equivalent to or less than the T-rating of this area (for example, T6 is a lower T-rating than T3).

If the T-rating for the area has not been defined,

- Select material with the lowest AIT in °C.
- This temperature is the maximum allowable heating cable sheath temperature.

T-rating = 498°C

The purpose of the T-rating is to ensure that electrical equipment does not exceed the auto-ignition temperatures of flammables handled in a hazardous (Classified) area.

The heating cable selected cannot have a maximum sheath temperature greater than the lowest AIT for the area.

Step 3. Calculate the temperature differential (ΔT):

$\Delta T = T_M - T_A$

Example:

Calculate $\Delta T = T_M - T_A$

Calculate ΔT = 40°F – (–20°F) [4.4°C – (–28.9°C)]

Calculate ΔT = 60°F (33.3°C)

Step 4. Determine the pipe heat loss:

From Table 3 match the pipe size and insulation thickness with the temperature differential (ΔT) to find the base heat loss of the pipe (Q_B).

Example:

From Table 3, 6" pipe, 2" insulation, and ΔT = 60°F (33.3°C), Q_B must be calculated through interpolation:

$Q_B = 4.2 \text{ W/ft} + 10/50 \times (8.8 - 4.2) = 4.2 + 0.9$

$Q_B = 5.1 \text{ W/ft} @ T_M = 40°F (4.4°C)$

Step 5. Compensate for insulation type:

Note: Heat-loss calculations are based on IEEE Standard 515-1996, Equation 1.

Multiply the base heat loss of the pipe (Q_B) from Step 4 by the appropriate insulation compensation factor (f) from Table 4 to get the actual heat loss (Q_T).

$Q_T = Q_B \times f$

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Example:

From Table 4, insulation factor (f) = 1.48 for calcium silicate:

$Q_T = Q_B \times f$

$Q_B = 5.1$ W/ft x 1.48

$Q_T = 7.5$ W/ft at 40°F (4.4°C)

Step 6. Select the thermal output rating:

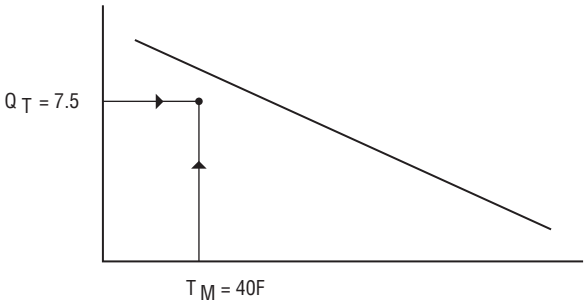
From Graphs 1 and 2, match the actual heat loss per foot of pipe (Q_T) with the desired maintenance temperature (T_M), and select from the power output ratings so that the power output rating at T_M equals or exceeds Q_T.

Example:

$Q_T = 7.5$ W/ft

$T_M = 40$°F (4.4°C)

From Graphs 1 and 2, 8HBTV-CT exceeds 7.5 W/ft at 40°F (4.4°C).



Should the heat loss Q_T be between the two heating-cable power output curves, select the higher-rated heating cable. If the heat loss Q_T is greater than the power output of the highest-rated heating cable, you can compensate with one of the following methods:

- Use thicker insulation.
- Use insulation material with a lower K factor.
- Use two or more heating cables run in parallel.
- Spiral the heating cable.

Spiraling: If this method is selected, determine the spiral factor according to the following formula:

$$\text{Spiral factor (length of heating cable/foot of pipe)} = \frac{Q_T}{\text{Heater thermal output at } T_M}$$

When the spiral factor exceeds 1.4 or the pipe size is less than 3" IPS, nVent recommends using two or more heating cables run in parallel.

Only HBTV-CT and BTV-CT can be used on plastic pipes. See Appendix H for thermal output adjustment factors on plastic pipes.

Step 7. Determine the heating cable family:

Select the heating cable catalog number based on the following information and Table 1 below:

- Maintenance temperature
- Heat loss calculated (Q_T)

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- Service voltage
- Approval requirement
- T-rating as calculated by your required approval agency
- Continuous exposure temperature

Note: Make sure that the maximum sheath temperature of the heating cable is not higher than the T-rating (refer to Step 2). Contact the nVent Customer Service Center if the maximum sheath temperature of the heating cable selected exceeds the temperature calculated in Step 2.

TABLE 1 HEATING CABLE PRODUCT PERFORMANCE DATA

FM Approved heating cable temperature	CSA Certified heating cable	Maximum continuous exposure temperature*	Maximum intermittent exposure temperature**	T-rating/Maximum sheath
HBTV-CT	BTV-CT	150°F (65°C)	185°F (85°C)	T6 (185°F, 85°C)
HQTV-CT	QTVR-CT	225°F (110°C)	225°F (110°C)	T4 (275°F, 135°C)
5HXTV1, 2-CT	5XTV1, 2-CT-T3	250°F (121°C)	482°F (250°C)1	T3 (392°F, 200°C)
10HXTV1, 2-CT	10XTV1, 2-CT-T3	250°F (121°C)	482°F (250°C)1	T3 (392°F, 200°C)
15HXTV2-CT	15XTV2-CT-T3	250°F (121°C)	482°F (250°C)1	T3 (392°F, 200°C)
15HXTV1-CT	15XTV1-CT-T2	250°F (121°C)	482°F (250°C)1	T2D (419°F, 215°C)
20HXTV1-CT	20XTV1-CT-T2	250°F (121°C)	482°F (250°C)1	T2C (446°F, 230°C)
20HXTV2-CT	20XTV2-CT-T2	250°F (121°C)	482°F (250°C)1	T2C (446°F, 230°C)

* With the heating cable power on.

** 1000 hours (power on/power off).

[1] The 250°C rating applies to all products printed "MAX INTERMITTENT EXPOSURE 250C"

Example:

T_M = 40°F (4.4°C)

Actual heat loss calculated (Q_T) = 7.5 W/ft. Based on T_M = 40°F (4.4°C) and Q_T = 7.5 W/ft, an 8-W/ft product is sufficient for the application (refer to Step 6).

Service voltage = 240 V

T-rating = 498°C

Continuous exposure temperature = 100°F (37.8°C)

Therefore, choose 8HBTV2-CT.

Step 8. Calculate the total length of heating cable required by combining lengths from each component of the piping system:

Example:

80-ft pipe length

2 gate valves

5 0.25-in steel-welded shoe supports

1 power connection

1 end seal

(A) For the piping:

Determine the amount of heating cable required for the pipeline length.

Heating cable required for pipe length = 80 ft

(B) For each valve:

Use Table 2 on the next page to calculate the amount of heating cable required.

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TABLE 2 AMOUNT OF HEATING CABLE TO USE PER VALVE

Pipe diameter (IPS) (inches)	Minimum amount of heating cable (feet)	
1/4	0.3	For pipe diameters less than 2 inches, the numbers represent the maximum amount of heating cable that will fit on the valve.
1/2	0.8	
3/4	1.3	
1	2	
1/4	3.3	
1/2	4.3	
2	4.3	For pipe diameters between 2 and 6 inches, the numbers represent the maximum heating cable required to compensate for heat loss and a service loop.
3	4.3	
4	4.3	
6	5.0	
8	5.0	For pipe diameters greater than 6 inches, the numbers represent the minimum amount required for a service loop and do not necessarily compensate for total heat loss.
10	5.6	
14	7.3	
18	9.4	
24	12.6	

Note: Use TraceCalc 5 software to calculate the exact quantity required for the valve, based on Finite Element Analysis.

Heating cable required for valves = Two 6" valves x 4.3 ft = 8.6 ft

(C) For each pipe support shoe:

Calculate the additional heat required as follows:

$Q_{SUPPORT} = 0.7L \times (T_M - T_A)$, where L = Support length (ft)

Total heat loss from supports: 5 pipe supports x [0.7 x 1] x 60 = 210 W x 10% safety factor = 231 W

Calculate the additional heating cable required by dividing the total support heat loss, $Q_{SUPPORT,}$ by the heating cable power output per foot at T_M from the thermal output curves in Table 2.

$$\text{Heating cable required for supports} = \frac{231\ \text{W}}{8.8\ \text{W/ft}} = 26.3\ \text{ft}$$

(D) For components:

Allow an additional 3 feet for each component. For this example, assume one power connection kit and one end seal, so total cable required for components is 6 feet.

Total Heating Cable Required = (A) + (B) + (C) + (D)

80 + 8.6 + 26.3 + 6 = 121 feet

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TABLE 4 PIPE HEAT LOSS (W/FT)

			Pipe diameter (IPS) in inches							
			1/4	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2
	(ΔT)		Tubing size (inches)							
Insulation thickness	°F	°C		3/4	1	1-1/4	1-1/2	2		
0.5"	50	28	1.9	2.5	2.9	3.5	4.1	4.6	5.5	6.5
	100	56	3.9	5.2	6.1	7.2	8.6	9.6	11.5	13.5
	150	84	6.1	8.1	9.5	11.2	13.4	14.9	17.9	21.1
	200	111	8.5	11.3	13.2	15.6	18.6	20.7	24.9	29.2
1.0"	50	28	1.3	1.6	1.9	2.2	2.5	2.8	3.2	3.8
	100	56	2.7	3.4	3.9	4.5	5.2	5.8	6.8	7.8
	150	83	4.2	5.3	6.1	7.0	8.2	9.0	10.6	12.2
	200	111	5.8	7.4	8.4	9.7	11.3	12.4	14.6	16.9
	250	139	7.6	9.7	11.0	12.7	14.8	16.3	19.1	22.1
1.5"	50	28	1.1	1.3	1.5	1.7	1.9	2.1	2.4	2.8
	100	56	2.2	2.8	3.1	3.5	4.0	4.4	5.1	5.8
	150	83	3.5	4.3	4.8	5.5	6.3	6.9	8.0	9.1
	200	111	4.8	5.9	6.7	7.6	8.7	9.5	11.0	12.6
	250	139	6.3	7.8	8.7	9.9	11.4	12.4	14.4	16.5
	300	167	7.9	9.7	11.0	12.4	14.3	15.6	18.1	20.6
	350	194	9.6	11.9	13.3	15.1	17.4	19.0	22.0	25.1
2.0"	50	28	0.9	1.1	1.3	1.4	1.6	1.8	2.0	2.3
	100	56	2.0	2.4	2.7	3.0	3.4	3.7	4.2	4.8
	150	83	3.1	3.7	4.2	4.7	5.3	5.8	6.6	7.5
	200	111	4.3	5.2	5.8	6.5	7.4	8.0	9.2	10.4
	250	139	5.6	6.8	7.5	8.5	9.6	10.4	12.0	13.5
	300	167	7.0	8.5	9.4	10.6	12.1	13.1	15.0	17.0
	350	194	8.5	10.3	11.5	12.9	14.7	15.9	18.2	20.6
2.5"	50	28	0.9	1.0	1.2	1.3	1.4	1.6	1.8	2.0
	100	56	1.8	2.2	2.4	2.7	3.0	3.3	3.7	4.2
	150	83	2.8	3.4	3.7	4.2	4.7	5.1	5.8	6.5
	200	111	3.9	4.7	5.2	5.8	6.5	7.0	8.0	9.0
	250	139	5.1	6.1	6.8	7.6	8.5	9.2	10.5	11.7
	300	167	6.4	7.7	8.5	9.5	10.7	11.5	13.1	14.7
	350	194	7.8	9.3	10.3	11.5	13.0	14.0	15.9	17.9
3.0"	50	28	0.8	1.0	1.1	1.2	1.3	1.4	1.6	1.8
	100	56	1.7	2.0	2.2	2.4	2.7	2.9	3.3	3.7
	150	83	2.6	3.1	3.4	3.8	4.3	4.6	5.2	5.8
	200	111	3.6	4.3	4.8	5.3	5.9	6.4	7.2	8.0
	250	139	4.8	5.7	6.2	6.9	7.8	8.3	9.4	10.5
	300	167	6.0	7.1	7.8	8.7	9.7	10.4	11.8	13.2
	350	194	7.3	8.6	9.5	10.5	11.8	12.7	14.3	16.0
4.0"	50	28	0.7	0.9	0.9	1.0	1.1	1.2	1.4	1.5
	100	56	1.5	1.8	2.0	2.1	2.4	2.5	2.9	3.2
	150	83	2.4	2.8	3.0	3.4	3.7	4.0	4.4	4.9
	200	111	3.3	3.9	4.2	4.6	5.2	5.5	6.2	6.8
	250	139	4.3	5.1	5.5	6.1	6.7	7.2	8.1	8.9
	300	167	5.4	6.3	6.9	7.6	8.5	9.0	10.1	11.2
	350	194	6.6	7.7	8.4	9.3	10.3	11.0	12.3	13.6

Note: Pipe heat loss (Q_B) is shown in watts per foot. Heat loss calculations are based on IEEE Standards with the following provisions:

- Pipes insulated with glass fiber in accordance with ASTM C547
- Pipes located outdoors in a 20-mph wind
- No insulating air space assumed between pipe and insulation
- No insulating air space assumed between the insulation and outer cladding
- Includes a 10% safety factor

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Thermal Design

TABLE 4 PIPE HEAT LOSS (W/FT)

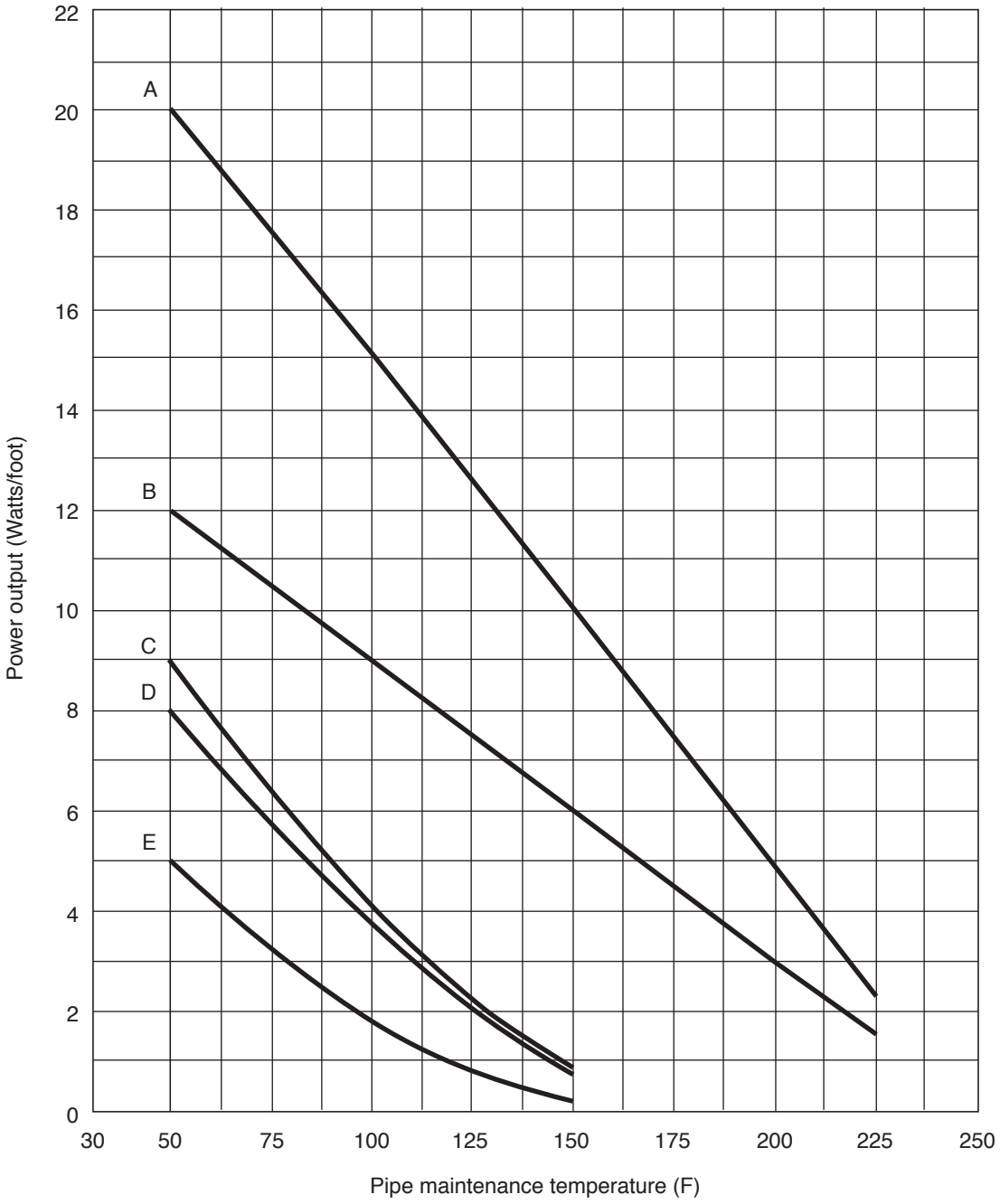
Pipe diameter (IPS) in inches											
3	3-1/2	4	6	8	10	12	14	16	18	20	24
7.7	8.6	9.6	13.6	17.4	21.4	25.2	27.5	31.3	35.0	38.8	46.2
16.0	18.0	20.0	28.4	36.3	44.6	52.5	57.4	65.2	73.0	80.8	96.3
25.0	28.1	31.2	44.3	56.6	69.6	81.9	89.5	101.7	113.8	126.0	150.2
34.6	39.0	43.3	61.5	78.6	96.6	113.6	124.2	141.1	158.0	174.8	208.5
4.4	4.9	5.4	7.5	9.4	11.5	13.5	14.7	16.6	18.6	20.5	24.4
9.1	10.2	11.2	15.6	19.7	24.0	28.1	30.6	34.7	38.7	42.8	50.9
14.2	15.9	17.5	24.3	30.7	37.4	43.8	47.8	54.1	60.4	66.7	79.4
19.7	22.0	24.2	33.7	42.5	51.9	60.7	66.2	75.0	83.8	92.5	110.0
25.8	28.7	31.7	44.0	55.6	67.9	79.4	86.6	98.1	109.6	121.0	143.9
3.2	3.6	3.9	5.3	6.7	8.1	9.4	10.2	11.5	12.9	14.2	16.8
6.7	7.4	8.1	11.1	13.9	16.8	19.6	21.3	24.0	26.8	29.5	35.0
10.5	11.6	12.7	17.3	21.6	26.2	30.5	33.2	37.5	41.8	46.1	54.6
14.5	16.1	17.6	24.0	30.0	36.3	42.3	46.0	52.0	57.9	63.8	75.7
19.0	21.0	23.0	31.4	39.2	47.5	55.3	60.2	68.0	75.7	83.5	99.0
23.8	26.3	28.8	39.3	49.2	59.6	69.3	75.4	85.1	94.9	104.6	124.0
28.9	32.0	35.0	47.8	59.8	72.4	84.3	91.7	103.5	115.4	127.2	150.8
2.6	2.9	3.1	4.2	5.2	6.3	7.3	7.9	8.9	9.9	10.9	12.9
5.5	6.0	6.6	8.8	10.9	13.1	15.2	16.5	18.6	20.7	22.8	26.9
8.5	9.4	10.2	13.8	17.0	20.5	23.8	25.8	29.0	32.3	35.5	42.0
11.8	13.0	14.2	19.1	23.6	28.4	32.9	35.7	40.2	44.7	49.2	58.2
15.5	17.0	18.5	24.9	30.9	37.2	43.1	46.7	52.6	58.5	64.3	76.1
19.4	21.3	23.2	31.2	38.7	46.6	54.0	58.6	65.9	73.3	80.6	95.3
23.6	25.9	28.3	38.0	47.1	56.6	65.6	71.2	80.2	89.1	98.1	115.9
2.3	2.5	2.7	3.6	4.4	5.2	6.1	6.6	7.4	8.2	9.0	10.6
4.7	5.2	5.6	7.4	9.1	10.9	12.6	13.7	15.3	17.0	18.7	22.0
7.4	8.1	8.7	11.6	14.2	17.0	19.7	21.3	23.9	26.5	29.1	34.3
10.2	11.2	12.1	16.1	19.7	23.6	27.2	29.5	33.1	36.7	40.3	47.5
13.3	14.6	15.8	21.0	25.8	30.9	35.6	38.6	43.3	48.0	52.8	62.2
16.7	18.3	19.8	26.3	32.3	38.7	44.6	48.4	54.3	60.2	66.1	77.9
20.3	22.2	24.1	32.0	39.3	47.1	54.3	58.8	66.0	73.2	80.4	94.7
2.0	2.2	2.4	3.1	3.8	4.5	5.2	5.6	6.3	7.0	7.6	9.0
4.2	4.6	4.9	6.5	7.9	9.4	10.8	11.7	13.1	14.5	15.9	18.7
6.6	7.1	7.7	10.1	12.4	14.7	16.9	18.3	20.5	22.6	24.8	29.2
9.1	9.9	10.7	14.0	17.1	20.4	23.4	25.3	28.3	31.4	34.4	40.4
11.9	12.9	14.0	18.3	22.4	26.6	30.6	33.1	37.1	41.0	45.0	52.8
14.9	16.2	17.5	23.0	28.1	33.4	38.4	41.5	46.5	51.4	56.3	66.2
18.1	19.7	21.3	28.0	34.1	40.6	46.7	50.5	56.5	62.5	68.5	80.5
1.7	1.8	2.0	2.5	3.1	3.6	4.1	4.4	5.0	5.5	6.0	7.0
3.5	3.8	4.1	5.3	6.4	7.5	8.6	9.3	10.3	11.4	12.4	14.5
5.5	6.0	6.4	8.3	10.0	11.8	13.4	14.5	16.1	17.8	19.4	22.7
7.6	8.3	8.9	11.4	13.8	16.3	18.6	20.0	22.3	24.6	26.9	31.4
10.0	10.8	11.6	15.0	18.1	21.3	24.3	26.2	29.2	32.2	35.2	41.1
12.5	13.5	14.6	18.8	22.6	26.7	30.5	32.8	36.6	40.3	44.1	51.5
15.2	16.5	17.7	22.8	27.5	32.4	37.1	39.9	44.5	49.0	53.6	62.6

TABLE 5 INSULATION FACTORS

Preformed pipe insulation	Insulation factor (f)	K factor at 50°F (BTU/hr–°F–ft²/in)*
Glass fiber (ASTM C547)	1.00	.25
Calcium silicate (ASTM C533)	1.48	.37
Cellular glass (ASTM C552)	1.48	.33
Rigid cellular urethane (ASTM C591)	0.64	.16
Foamed elastomer (ASTM C534)	1.16	.29
Mineral fiber blanket (ASTM C553)	1.16	.30
Expanded perlite (ASTM C610)	1.90	.48

Heat-Tracing Systems for Hazardous Division 1 Locations

Graph 1. Thermal Output Ratings for HBTV/BTV and HQTV/QTVR Solid-Core Heating Cables on Insulated Metal Pipes (Nominal)



	FM Approved heating cables	CSA Certified heating cables
A	20HQTV1, 2-CT	20QTVR1, 2-CT
B	12HQTV1, 2-CT	10QTVR1, 2-CT
C	10HBTV1, 2-CT	10BTV1, 2-CT
D	8HBTV1, 2-CT	8BTV1, 2-CT
E	5HBTV1, 2-CT	5BTV1, 2-CT

Note: Watts/foot x 3.28 = Watts/meter

(°F–32) x 5/9 =°C

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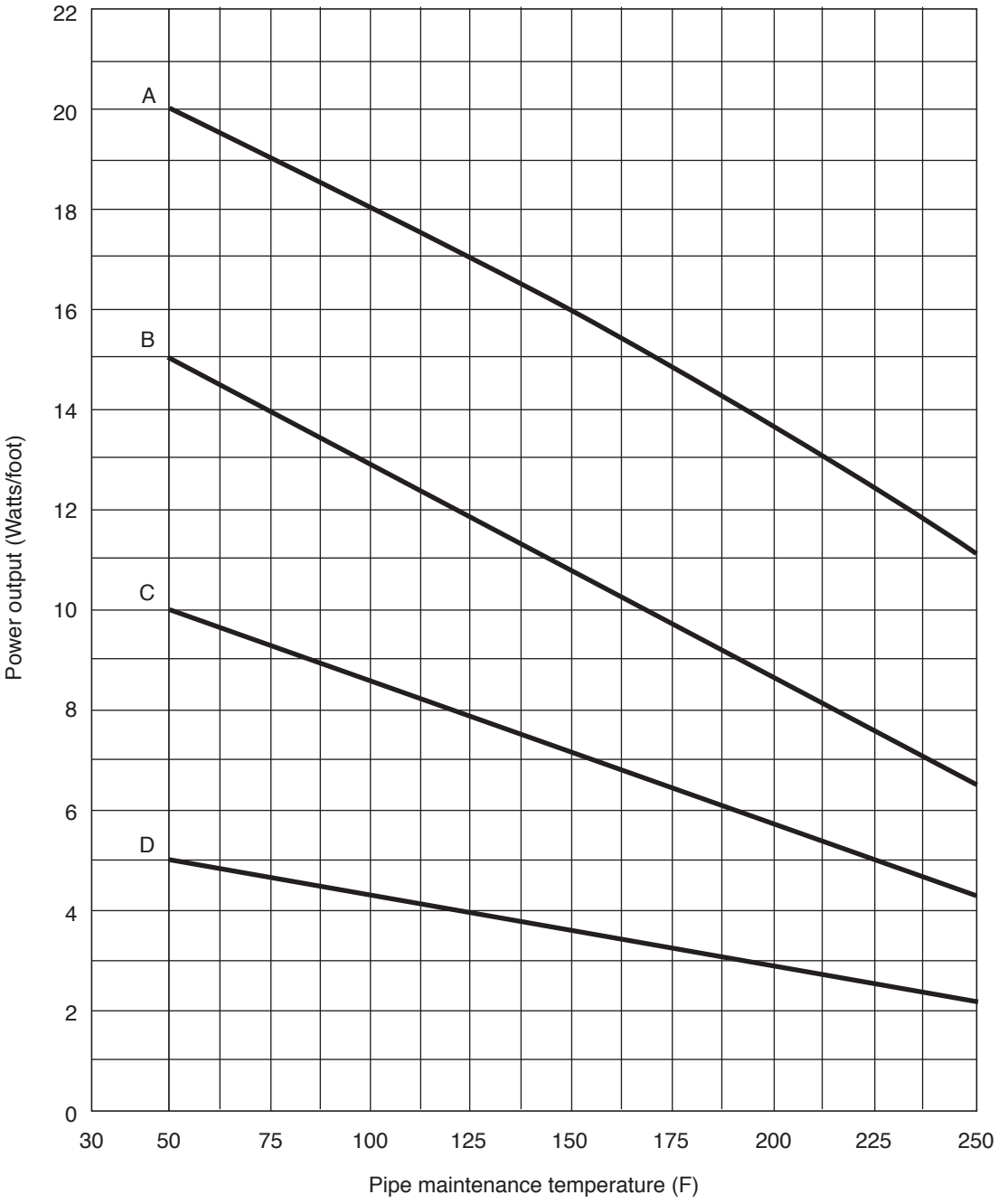
Thermal Design

Graph 2. Thermal Output Ratings for HXTV/XTV Fiber-Wrapped Heating Cables on Insulated Metal Pipes (Nominal)



	FM Approved heating cables	CSA Certified heating cables
A	20HXTV1, 2-CT	20XTV1, 2-CT-T2
B	15HXTV1-CT 15HXTV2-CT	15XTV1-CT-T2 15XTV2-CT-T3
C	10HXTV1, 2-CT	10XTV1, 2-CT-T3
D	5HXTV1, 2-CT	5XTV1, 2-CT-T3

Heat-Tracing Systems for Hazardous Division 1 Locations

3.1 Introduction

In order to comply with requirements of nVent, the NEC, FM, and CSA, ground-fault equipment protection devices (GFEPDs) providing a minimum leakage current to ground trip level of 30 mA must be used. GFEPDs are commonly available with current over-trip ratings up to 30 A for 120, 208, and single-phase 240-Vac grounded systems.

3.2 Special Considerations

In temperature-sensitive applications, thermostatic control may be necessary. If maximum temperature is a concern, consult the nVent Customer Service Center for design assistance.

3.3 Circuit Breaker Selection

Note: Ground-fault circuit interrupters (GFCIs) provide leakage current to ground trip level of 4 to 6 mA for personnel protection. Use of these devices in the place of GFEPDs may cause nuisance tripping in some circumstances.

⚠ **WARNING:** To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with nVent requirements, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit breakers.

⚠ **WARNING:** Disconnect all power before making connections to the heating cable.

To determine the circuit breaker sizing, you must know the following:

- Heater type
- Total heater length

Using Table 5 on the next page, match your heating cable catalog number at the minimum startup temperature with your total heating cable length to select a circuit breaker trip rating.

Example:

In the example in Section 2.0, Step 8, the total heating cable circuit length is 121 feet. As shown in Table 5, the maximum heating cable length allowed for 8HBTV-CT powered at 240 volts with a 0°F startup temperature on a 15-A circuit breaker is 200 feet. Select the 15-A circuit breaker.

Circuit breaker trip rating: 15 A

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Thermal Design

TABLE 5. CIRCUIT BREAKER SELECTION

Use the following table to match the heating cable catalog number at the expected minimum start-up temperature with the total heating cable length and select a circuit breaker trip rating. The circuit breaker trip rating should not exceed the maximum trip rating shown for heating cables in that family. For example, the trip rating of a circuit breaker protecting several 10HXTV-CT circuits should not exceed 50 amps.
To maximize fault current protection, use the lowest allowable circuit breaker.

Maximum circuit length per breaker depends on four factors:

1. Heating cable family and catalog number
2. Minimum start-up temperature
3. Service voltage
4. Circuit breaker trip rating

MAXIMUM HEATING CABLE LENGTH (FEET) VS. CIRCUIT BREAKER TRIP RATING (AMPS)

Startup temperature	120 volt 15A	20A	30A	40A	50A	240 volt 15A	20A	30A	40A	50A
5HBTV-CT, 5BTV-CT										
50°F (10°C)	230	270	270	270	*	460	540	540	540	*
0°F (–17.78°C)	140	185	270	270	*	280	375	540	540	*
–20°F (–28.89°C)	120	160	245	270	*	245	325	490	540	*
–40°F (–40°C)	105	145	215	270	*	215	290	435	540	*
8HBTV-CT, 8BTV-CT										
50°F (10°C)	150	200	210	210	*	300	400	420	420	*
0°F (–17.78°C)	100	130	200	210	*	200	265	400	420	*
–20°F (–28.89°C)	85	115	175	210	*	175	235	350	420	*
–40°F (–40°C)	75	105	155	210	*	155	210	315	420	*
10HBTV-CT, 10BTV-CT										
50°F (10°C)	120	160	180	180	*	240	320	360	360	*
0°F (–17.78°C)	75	105	155	180	*	155	210	315	360	*
–20°F (–28.89°C)	65	90	135	180	*	135	185	275	360	*
–40°F (–40°C)	60	80	120	165	*	120	165	245	330	*
12HQTV-CT, 10QTVR-CT										
50°F (10°C)	100	130	195	195	*	200	265	390	390	*
0°F (–17.78°C)	80	105	160	195	*	160	210	320	390	*
–20°F (–28.89°C)	70	95	145	195	*	145	195	295	390	*
–40°F (–40°C)	65	90	135	180	*	135	180	275	365	*
20HQTV-CT, 20QTVR-CT										
50°F (10°C)	60	80	120	160	195	120	160	240	320	390
0°F (–17.78°C)	45	60	95	125	160	95	125	190	255	320
–20°F (–28.89°C)	40	55	85	115	145	85	115	175	235	295
–40°F (–40°C)	40	55	80	110	135	80	110	165	220	275

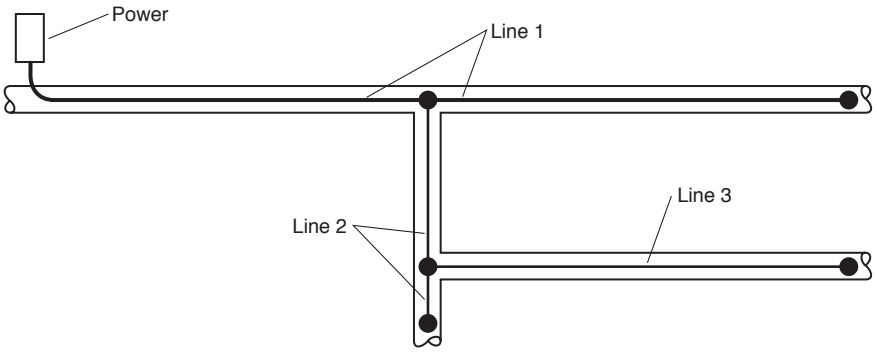
* These products cannot be used with a 50 A circuit breaker, due to possible bus wire overheating, which can damage the product.

Heat-Tracing Systems for Hazardous Division 1 Locations

TABLE 5. CIRCUIT BREAKER SELECTION (CONTINUED)

Maximum Heating Cable Length (feet) vs. Circuit Breaker Trip Rating (amps)

Startup temperature	120 volt 15A	20A	30A	40A	50A	240 volt 15A	20A	30A	40A	50A
5HXTV-CT, 5XTV-CT										
50°F (10°C)	180	240	260	380	380	360	480	720	765	765
0°F (–17.78°C)	155	210	315	380	380	315	420	630	765	765
–20°F (–28.89°C)	150	200	300	380	380	300	400	600	765	765
–40°F (–40°C)	145	190	285	380	380	285	380	570	765	765
10HXTV-CT, 10XTV-CT										
50°F (10°C)	110	145	220	270	270	220	295	440	540	540
0°F (–17.78°C)	95	130	195	260	270	195	260	385	515	540
–20°F (–28.89°C)	90	120	185	245	270	185	245	370	490	540
–40°F (–40°C)	85	110	175	230	270	175	230	355	465	540
15HXTV-CT, 15XTV-CT										
50°F (10°C)	75	100	150	200	220	150	200	300	400	440
0°F (–17.78°C)	65	85	130	175	220	130	175	265	350	440
–20°F (–28.89°C)	60	80	125	165	210	125	165	250	335	420
–40°F (–40°C)	55	75	120	155	200	120	155	235	320	400
20HXTV-CT, 20XTV-CT										
50°F (10°C)	60	120	120	160	190	115	155	230	305	380
0°F (–17.78°C)	55	70	110	145	185	105	140	210	275	345
–20°F (–28.89°C)	50	70	105	140	170	100	130	200	260	330
–40°F (–40°C)	45	70	100	135	165	95	120	190	245	325



Line 1 + Line 2 + Line 3 ≤ Maximum circuit length

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Components And Electrical Connections

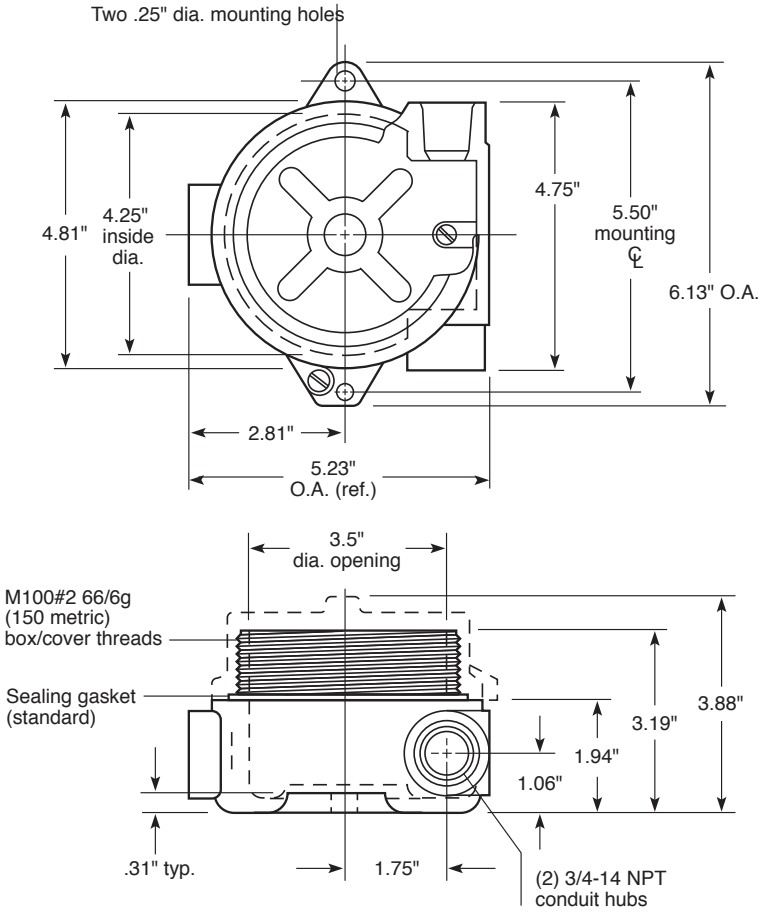
COMPONENTS AND ELECTRICAL CONNECTIONS

4.1 Power Connections, Splices, Tees, and End Seals

All power connections, splices, tees, and end seals in a Division 1 location must use the HAK-C-100 connection kit, along with a Division 1 Nationally Recognized Testing Lab (NRTL) approved junction box, which must be ordered separately.

Component matrix				Additional materials required	
Connection type	Number of HAK-C-100 kits required	Number of holes required on the junction box	Junction box catalog number	Mounting brackets	Pipe straps
Power	1	2	HAK-JB2	1	1
Splice	2	2	HAK-JB2	1	1
Tee	3	3	HAK-JB3	1	1
End seal	1	1	HAK-JB2	1	1

HAK-JB2 (shown) and HAK-JB3 Junction Boxes



Note:

- HAK-JB2 and HAK-JB3 junction boxes include an approved hole plug. Kit connections are 3/4" NPT.
- Any NRTL listed junction box suitable for a hazardous area may be used. However, some junction boxes may not be compatible with the RAYCHEM universal mounting bracket.

Heat-Tracing Systems for Hazardous Division 1 Locations

4.2 Core Sealing

There are two approved methods for core sealing: cold core sealing and heat-shrink core sealing. The HAK-C-100 kit includes components for each core sealing method. nVent recommends the cold core sealing method for easiest installation. Sections 5.5 and 5.6 describe the kit contents and installation for this method. For those customers that want to use the heat-shrink method, the kit contents and installation method are described in Appendix D.

4.3 Attachment Tapes

GT-66 Glass Installation Tape

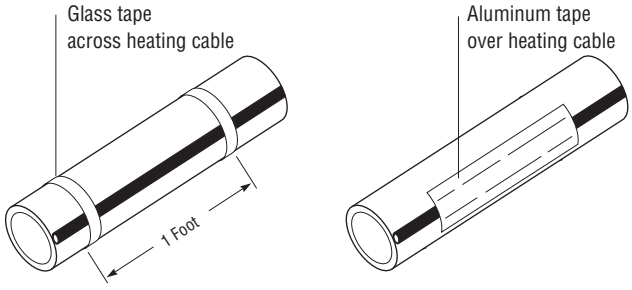
- For general use on pipes other than stainless steel
- 1/2" x 66' roll
- Temperature class: 266°F (130°C)
- Strap at 1-foot intervals
- Minimum application temperature: 40°F (4°C)

GS-54 Glass Installation Tape

- For use on stainless steel pipes
- 1/2" x 54' roll
- Temperature class: 356°F (180°C)
- Strap at 1-foot intervals
- Minimum application temperature: –40°F (–40°C)

AT-180 Aluminum Tape

- For use on pipes other than stainless steel
- 2 1/2" x 180' roll
- Temperature class: 300°F (150°C)
- Minimum application temperature: 32°F (0°C)



Tape Requirements

	Rolls needed per 100 feet of cable Pipe diameter (IPS)						
Tape type	**1/2"**	**1"**	**2"**	**3"**	**4"**	**6"**	**8"**
GT-66	0.6	1.2	4	4	6	8	10
GS-54	0.6	1.4	4	6	6	10	12
AT-180	Use 1 foot of tape per foot of pipe.						

4.4 ETL ELECTRIC TRACED LABELS

For use on the outside of thermal insulation weather barrier to indicate presence of electric heat-tracing circuit.

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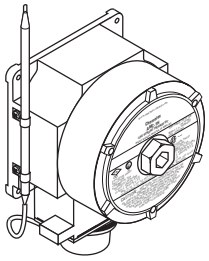
COMPONENTS AND ELECTRICAL CONNECTIONS

4.5 Thermostats

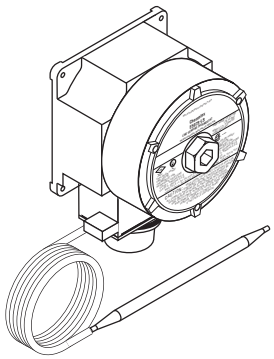
AMC-1H Ambient sensing thermostat for hazardous locations

Approvals	Hazardous locations Class I, Divisions 1 and 2, Groups B, C, D Class II, Divisions 1 and 2, Groups E, F, G Class III
Enclosure	NEMA 4, 7, 9 Lacquer-coated cast aluminum housing Stainless steel hardware
Sensor type	Fluid-filled (silicone) bulb and capillary
Sensor material	300 series stainless steel
Connection	Screw terminals accept #10–#14 AWG wire through 3/4" NPT conduit hub.
Range	15°F to 140°F (–9°C to 60°C)
Sensor exposure limits	–40°F to 160°F (–40°C to 71°C)
Housing exposure limits	–40°F to 160°F (–40°C to 71°C)
Switch	SPDT
Electrical rating	22 A at 125/250/480 Vac
Accuracy	±6°F (±3.3°C)
Deadband	3°F to 9°F (1.7°C to 5°C) above actuation temp.
Set point repeatability	±3°F (±1.7°C)



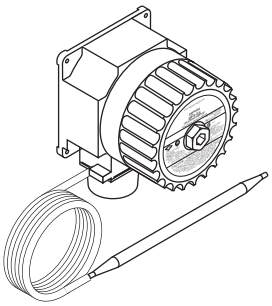
E507S-LS Line-sensing thermostat for hazardous locations

Approvals	Hazardous locations Class I, Divisions 1 and 2, Groups B, C, D Class II, Divisions 1 and 2, Groups E, F, G Class III
Enclosure	NEMA 4, 7, 9 Lacquer-coated cast aluminum housing Stainless steel hardware
Sensor type	Fluid-filled (silicone) bulb and 9-foot capillary
Sensor material	300 series stainless steel
Connection	Screw terminals accept #10–#14 AWG wire through 3/4" NPT conduit hub.
Range	25°F to 325°F (–4°C to 163°C)
Sensor exposure limits	–40°F to 420°F (–40°C to 215°C)
Housing exposure limits	–40°F to 160°F (–40°C to 71°C)
Switch	SPDT
Electrical rating	22 A at 125/250/480 Vac
Accuracy	±6°F (±3.3°C)
Deadband	3°F to 9°F (1.7°C to 5°C) above actuation temp.
Set point repeatability	±3°F (±1.7°C)



Heat-Tracing Systems for Hazardous Division 1 Locations

E507S-2LS Line-sensing thermostat for hazardous locations	
Approvals	Hazardous locations Class I, Divisions 1 and 2, Groups B, C, D Class II, Divisions 1 and 2, Groups E, F, G Class III
Enclosure	NEMA 4, 7, 9 Lacquer-coated cast aluminum housing Stainless steel hardware
Sensor type	Fluid-filled (silicone) bulb and 9-foot capillary
Sensor material	300 series stainless steel
Connection	Screw terminals accept #10–#14 AWG wire through 3/4" NPT conduit hub.
Range	25°F to 325°F (–4°C to 163°C)
Sensor exposure limits	–40°F to 420°F (–40°C to 215°C)
Housing exposure limits	–40°F to 160°F (–40°C to 71°C)
Switch	DPST
Electrical rating	22 A at 120/240/277 Vac
Relay coil	120 Vac, 4 VA
Accuracy	±6°F (±3.3°C)
Deadband	3°F to 9°F (1.7°C to 5°C) above actuation temp.
Set point repeatability	±3°F (±1.7°C)



Installation

5.1 Approvals and Warranty

For the FM Approval or CSA Certification and the nVent warranty to apply, installers must follow the instructions included in this guide. Installers must comply with all governing code requirements.

5.2 Heating Cable Installation Requirements

5.2.1 Heating Cable Storage

- Store the heating cable in a clean, dry place.
- Temperature range: –40 (40°C) to 140°F (60°C).
- Protect the heating cable from mechanical damage.

⚠ WARNING:
Fire and shock hazard.

- Do not install damaged cable.
- The black heating cable core and fibers are conductive and can short. They must be properly insulated and kept dry.
- Components and cable ends must be kept dry before and during installation.

5.2.2 Preinstallation Checks

Check materials received:

- Review the heating cable design and compare the list of materials with the catalog numbers of heating cables and electrical components received to confirm that proper materials are on-site. The heating cable type is printed on its jacket.
- Inspect heating cable and components for in-transit damage. Continuity and insulation resistance (megohmmeter) testing of each reel is recommended. See Section 5.10 for a test method.

Check piping to be traced:

- Make sure all mechanical pipe testing (for example, pipe pressure test) is complete.
- Walk the system and plan the routing of the cable on the pipe.

5.3 Heating Cable Installation

5.3.1 Heating Cable Handling

Heating cable handling tips:

- Paint and pipe coating must be dry to the touch before heating cable installation.
- When pulling the heating cable, avoid:
  - sharp edges
  - excessive pulling force
  - kinking and crushing
  - walking on the cable or running over it with equipment

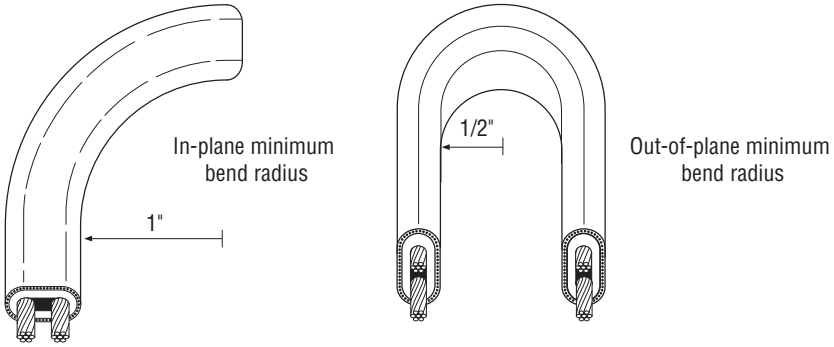
Heating cable pulling tips:

- Use a reel holder that pays out smoothly with little tension.
- Keep heating cable strung loosely but close to the pipe being traced, to avoid interference with supports and equipment.
- Leave a three-foot heating cable service loop at all power connection, splice, tee, and end seal locations.
- Add additional heating cable to trace the fittings and supports, or for spiraling as required by the design specifications. Consult Section 2.0, Thermal Design, for recommended allowances.
- Protect heating cable from moisture, contamination, and mechanical damage.

Heat-Tracing Systems for Hazardous Division 1 Locations

Heating cable minimum bend radius:

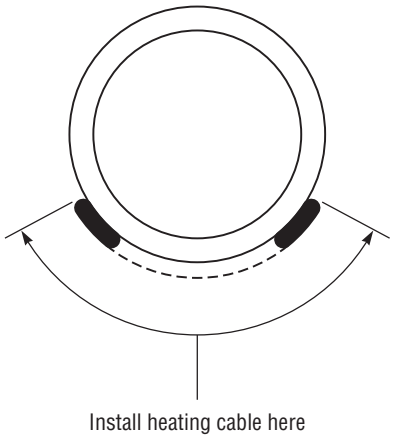
To prevent conductor damage and possible shorting, heating cable should not be bent to a radius of less than 1 inch in the in-plane direction or less than 1/2 inch in the out-of-plane direction.



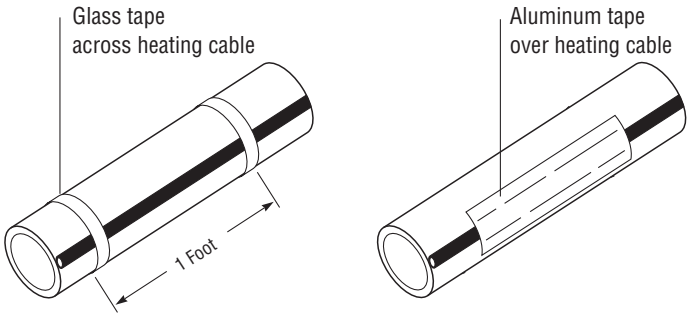
5.3.2 Heating Cable Positioning

The heating cable may be installed straight, spiraled, or in multiple runs as required by the design specification or nVent product literature.

Install the heating cable on the lower section of the pipe (as shown) to protect it from damage, unless using the spiraling method described in Section 5.3.6.



5.3.3 Heating Cable Attachment Recommendations



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5.3.4 Cutting the Heating Cable

Cut the heating cable after it is attached to the pipe. Before cutting it, confirm the tracing allowance per Section 2.3, Step 8.

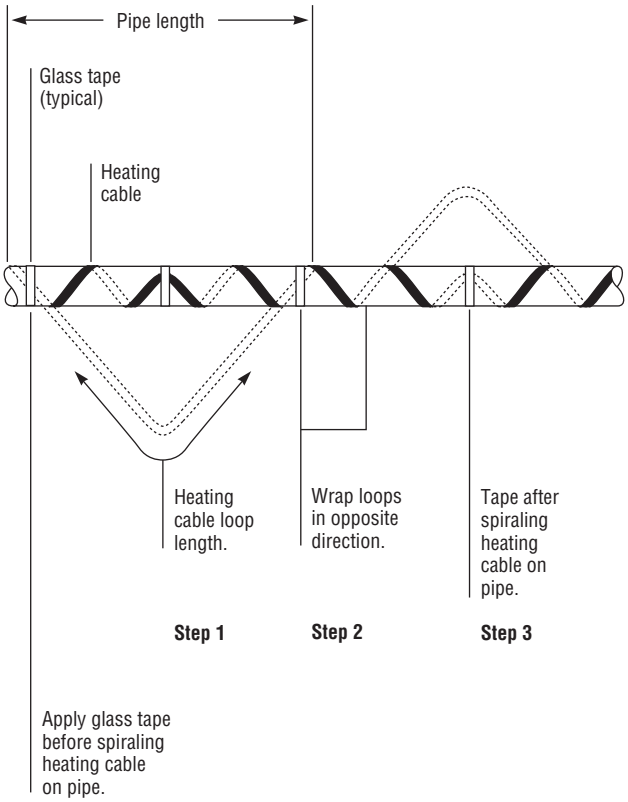
Heating cables can be cut to length without affecting the heat output per foot.

5.3.5 Typical Installation Details

Wrap pipe fittings and pipe supports as shown in the following installation details to properly compensate for higher heat-loss rates at heat sinks and to allow easy mechanical maintenance.

Consult the design specification or RAYCHEM product literature for the tracing requirements for fittings and supports.

5.3.6 Spiraling Method



Heating cable loop length = Pipe length x Spiral factor (see Section 2, Thermal Design)

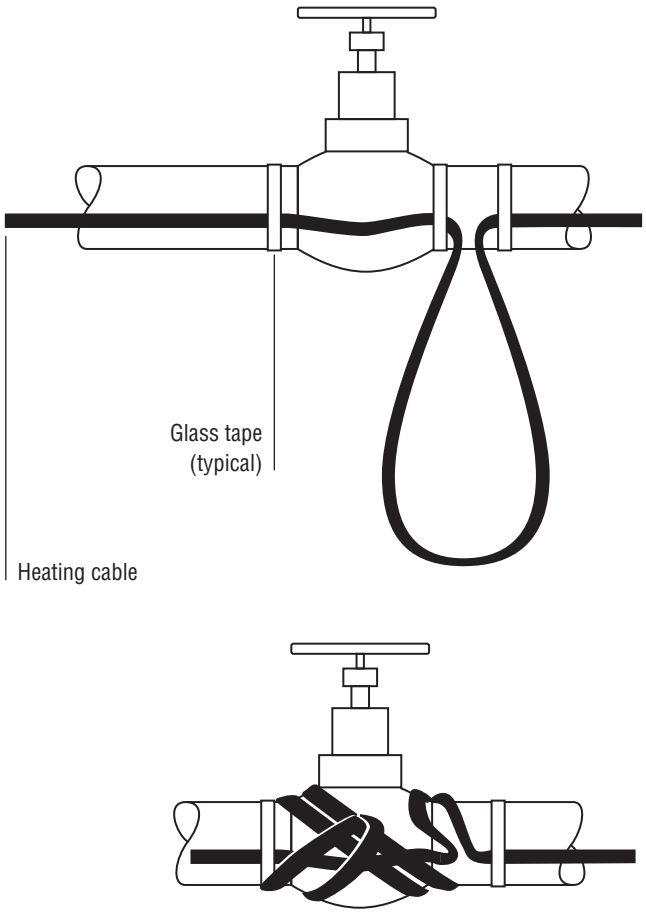
Step 1. Make the starting heating cable loop as shown.

Step 2. Grasp heating cable loop and wind around pipe.

Step 3. Space evenly and attach to pipe.

Heat-Tracing Systems for Hazardous Division 1 Locations

5.3.7 Valve (typical)



The drawing shows the general installation method. The heating cable configuration will vary for different valve shapes and pipe sizes.

Refer to Section 5.3.1, Heating Cable Handling, for heating cable minimum bend radius.

Refer to Table 2 in Section 2, nVent Thermal Design, for amount of heating cable to use per valve.

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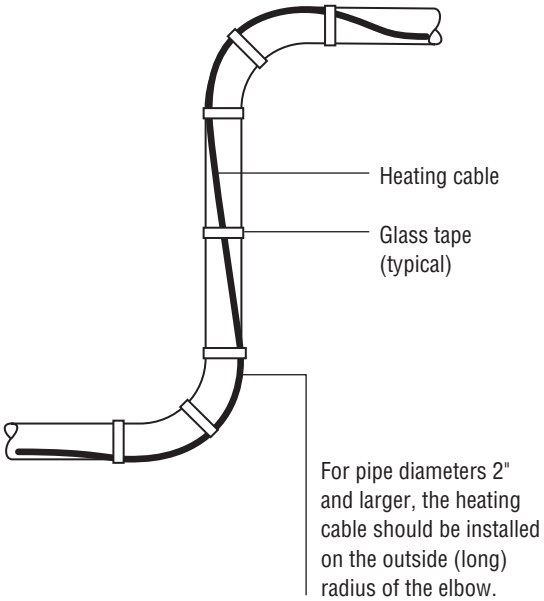
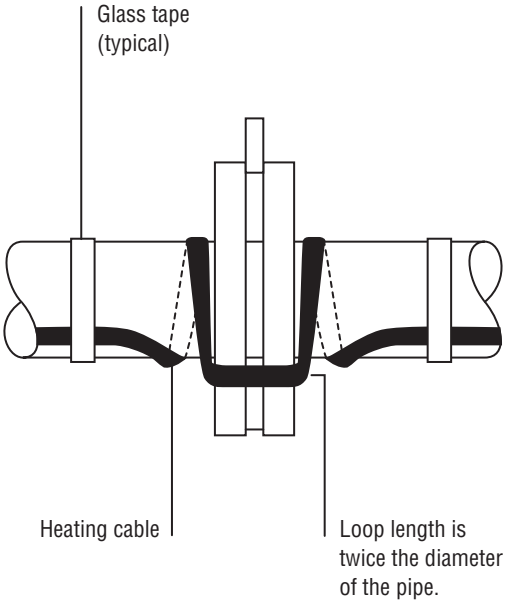
5.3.8 Elbow



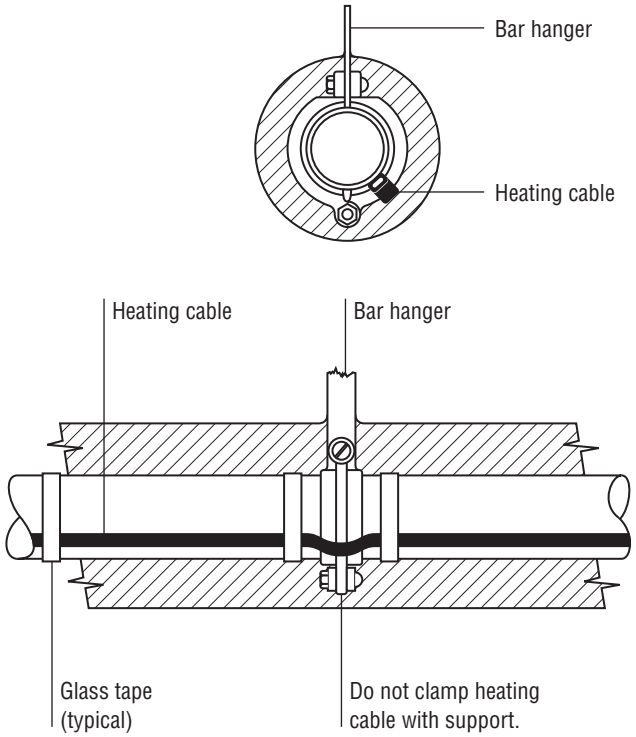
5.3.9 Flange



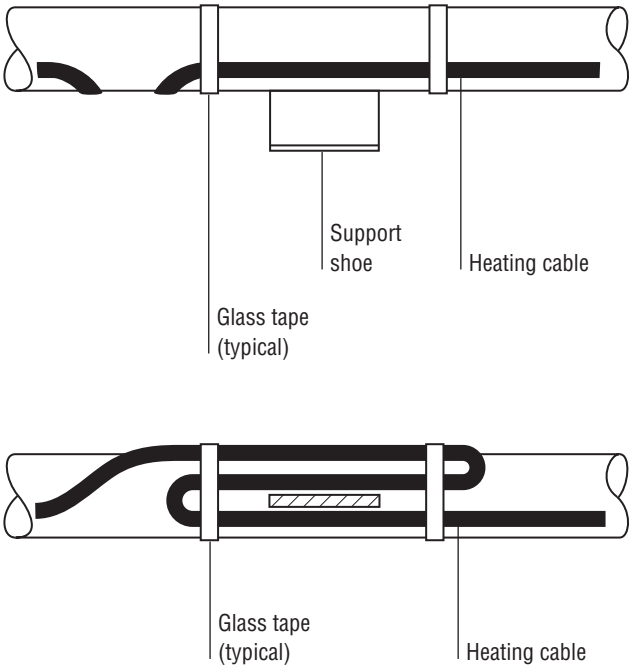
Note: Refer to page 24 for heating-cable minimum bend radius.

Heat-Tracing Systems for Hazardous Division 1 Locations

5.3.10 Pipe Bar Hanger



5.3.11 Pipe Support Shoe



Note: Refer to page 24 for heating-cable minimum bend radius.

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5.4 Component Installation Requirements

⚠ **WARNING:** Approvals and performance are based on the use of nVent-specified parts only. Do not substitute parts or use vinyl electrical tape.

The HAK-C-100 connection kit must be used in order to meet code, approval agency, and warranty requirements for Division 1 locations. Carefully follow all instructions and observe the following:

- Use only RAYCHEM Division 1 heating cables and the correct RAYCHEM components, as specified in this manual.
- Use a ground-fault equipment protection device for the circuit (see Section 5.9.4, GFEPD Wiring Schematics).
- Use the Installation Record, Appendix F, to ensure that the installation and checkout have been completed correctly.
- To ensure explosionproof connections, all fittings must be tight. Use recommended tools.
- Ketones and amines can dissolve the corrugated protective tubing. Protect the tubing from exposure to these chemicals wherever they may be present.
- Verify that the ambient temperature is above 32°F (0°C) before pouring seals.

5.5 Hak-C-100 Connection Kit Description

This kit includes approved components required for cold core sealing, to seal the entry of the RAYCHEM heating cables into an approved junction box for power connections, splices, tees, and end seals. Junction box, mounting bracket, and pipe strap are ordered separately.

An optional heat-shrink core sealer kit is provided for those customers wanting this option (see Appendix D).

HAK-C-100 Kit contents:

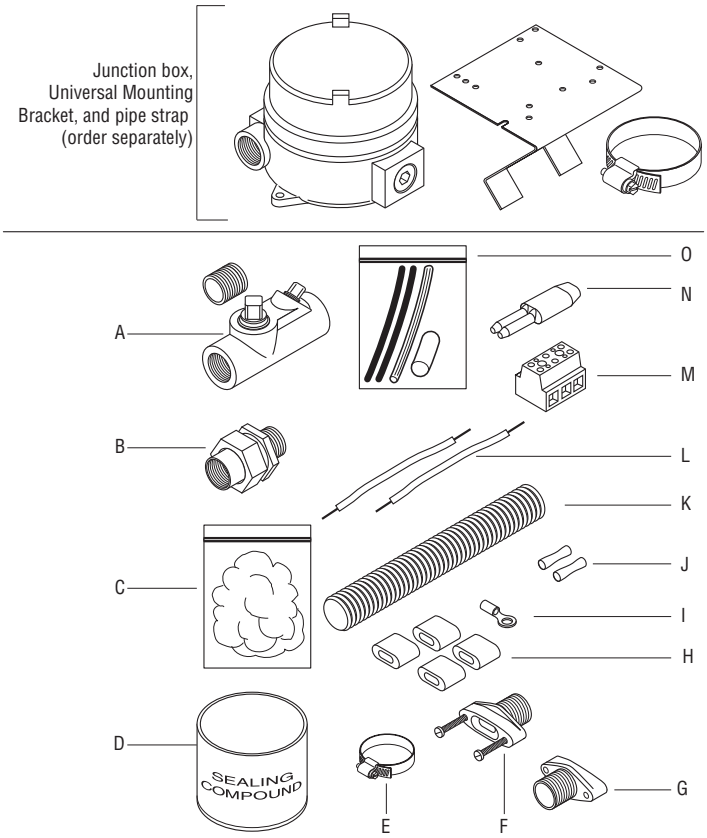
A 1 Sealing fitting and nipple
B 1 Union
C 1 Packing fiber
D 1 Sealing compound
E 1 Tubing clamp
F 1 Compression gland with threaded inserts
G 1 Compression gland
H 4 grommets (one each B, C, E, R)
I 1 Ring terminal
J 2 Butt connectors
K 1 Corrugated tubing
L 2 Cold leads
M 1 Terminal block
N 1 Core sealer
O 1 Yellow/green heat-shrink tubing
1 Heat-shrink core sealing kit

Additional materials that may be required and are available from nVent:

- Pipe strap, per pipe size
- Junction box
- Universal mounting bracket (UMB)
- Tape: GT-66, GS-54

Tools required:

- Flatblade screwdriver
- Utility knife
- Needle nose pliers
- Wire cutters/strippers
- Pipe wrench
- Ruler
- Small volume of water
- Crimp tool - Burndy MR8-9Q
- Crimp tool - Panduit CT-100



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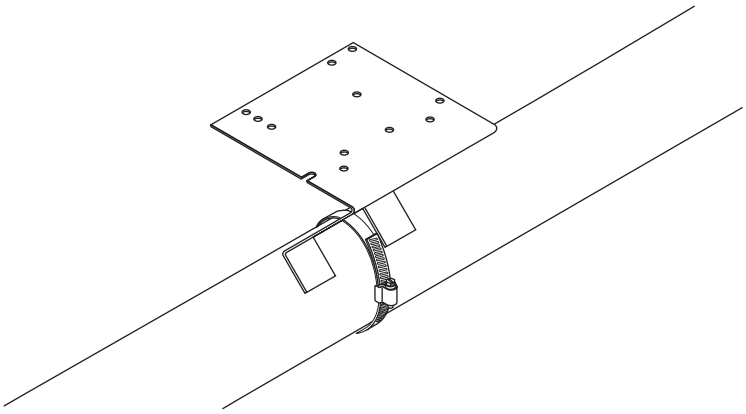
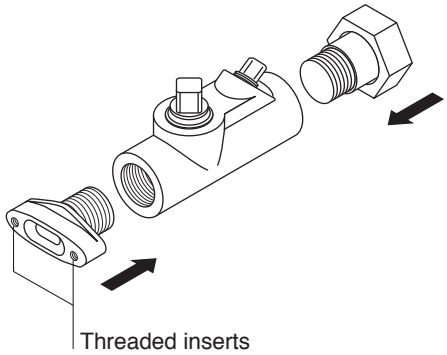
Installation

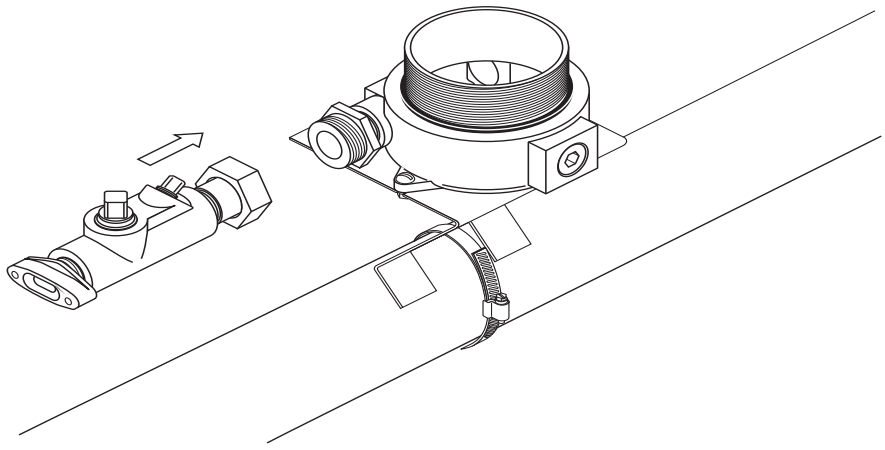
5.6 HAK-C-100 Connection Kit Installation



1. Fasten universal mounting bracket (UMB) on pipe, using appropriate size stainless steel pipe strap, or fabricate and locate suitable mounting plate for junction box within 24 inches of desired connection on pipe.



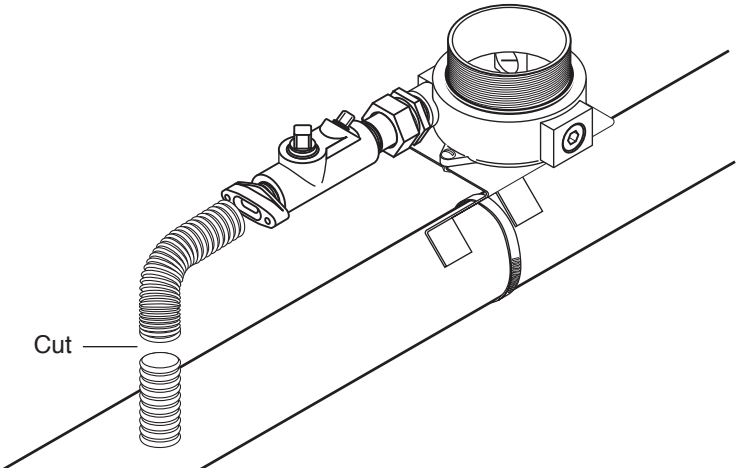
2. Thread compression gland half **with threaded inserts** into end of sealing fitting nearest vertical plug. Disassemble union. Thread female half of union onto nipple. Thread nipple into other end of sealing fitting nearest angled plug.

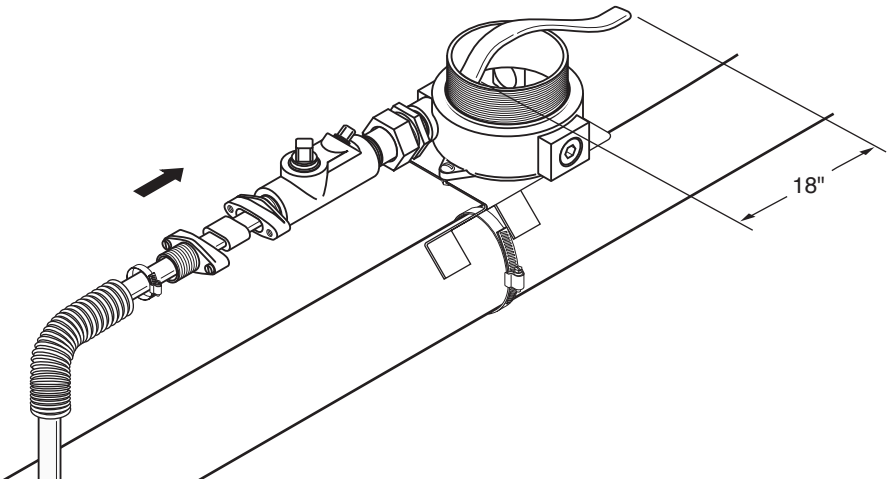


3. Thread male half of union into box entry. Assemble union halves together. Mount box on bracket.

⚠ **WARNING:** Correct grommet must be used for heating cable being installed or electrical hazard could result.

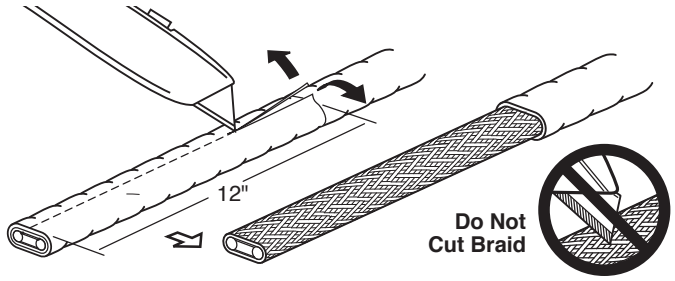
Heat-Tracing Systems for Hazardous Division 1 Locations





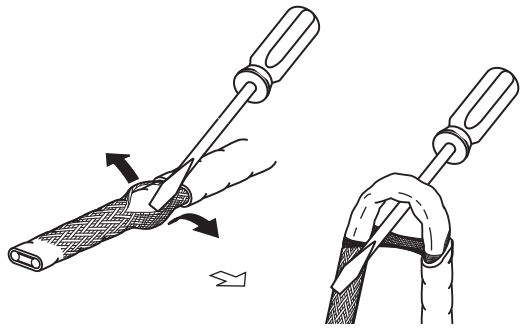
⚠ **WARNING:** Fire hazard. Do not cut braid or bus wires. Damaged heating cable must be replaced.

4. Corrugated tubing is provided. Measure length required to transition from compression gland to pipe surface, and cut to length.

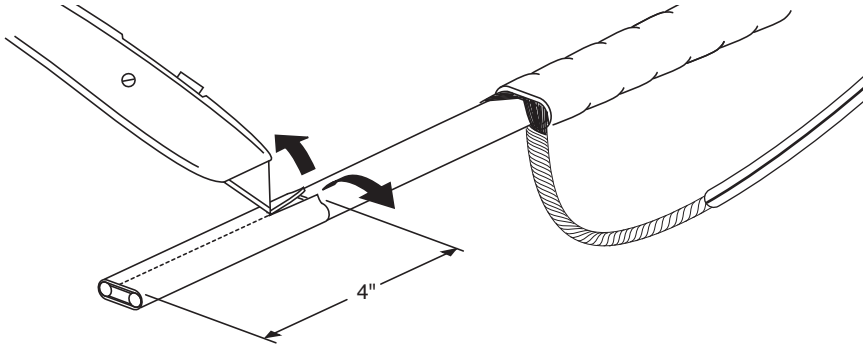


5. Being careful not to damage braid, score around outer heating cable jacket 12 inches from the end that extends out of the junction box. Score from this point to end of heating cable. Remove outer jacket.

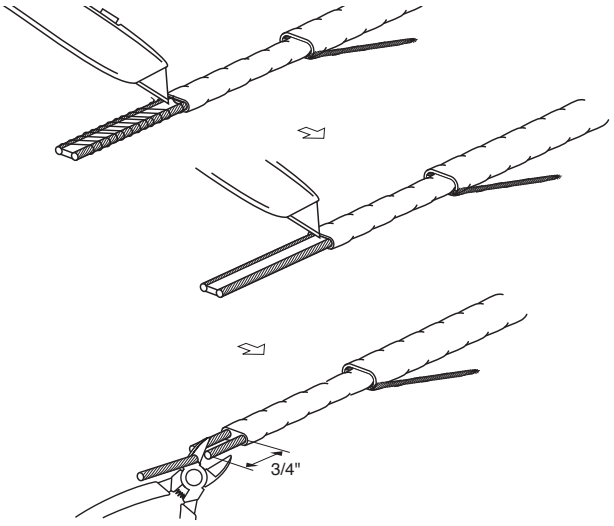
Installation



6. Using a small screwdriver as an aid, spread braid at base to expose inner jacket of heating cable. Bend heating cable at base of braid while pushing it through and working insulated heating cable out. Pull heating cable completely out of braid. Twist braid to form a tight pigtail. Slip yellow/green heat-shrink tube over braid to prevent stray braid wires from touching bus wires. Make sure yellow/green heat-shrink tube is located next to ring terminal to prevent interference with the sealing compound. Crimp ring terminal to braid pigtail using a Panduit CT-100 crimp tool. Trim braid if needed.

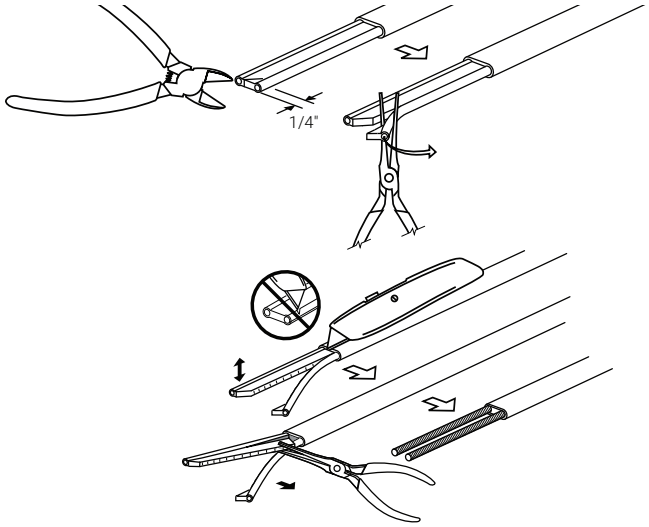


7. Score around inner jacket 4 inches from end. Score from this point to end of heating cable. Flex along score lines and remove inner jacket to expose polymer core material or fibers.

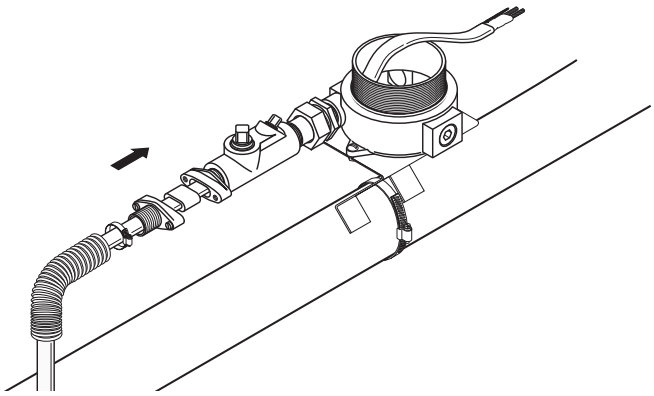


8. For fiber heating cables, cut and remove all fiber strands. Score and remove center spacer. Cut heating cable conductors to 3/4 inch. Clean bus wires.

Heat-Tracing Systems for Hazardous Division 1 Locations



9. For solid-core heating cables, notch core with diagonal cutters. Twist back and peel bus wire from core. Score core between bus wires at base jacket. Bend and snap core. Peel core free from bus wire. Cut heating cable conductors to 3/4 inch. Clean bus wires.



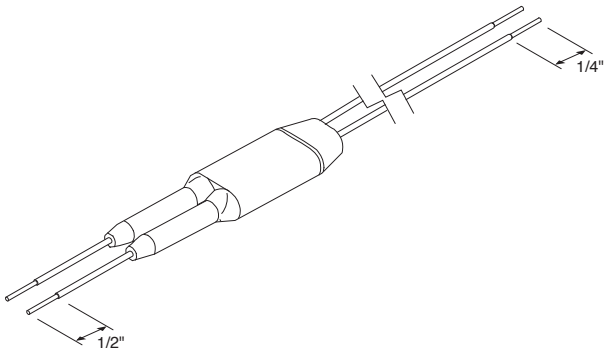
10. Slide corrugated protective tubing, tubing clamp, and other half of compression gland (without inserts) onto heating cable. Select correct grommet (see tables on the next page) and slide onto heating cable. Slide heating cable through all components and out top of junction box (see illustration). Allow 18 inches of heating cable to extend beyond box.

Heating Cable for FM Only	Grommet
5HBTV1, 2-CT	B
8HBTV1, 2-CT	C
10HBTV1, 2-CT	E
12HQTV1, 2-CT	C
20HQTV1, 2-CT	E
5HXTV1, 2-CT, 10HXTV1, 2-CT, 15HXTV1, 2-CT, 20HXTV1, 2-CT*	R

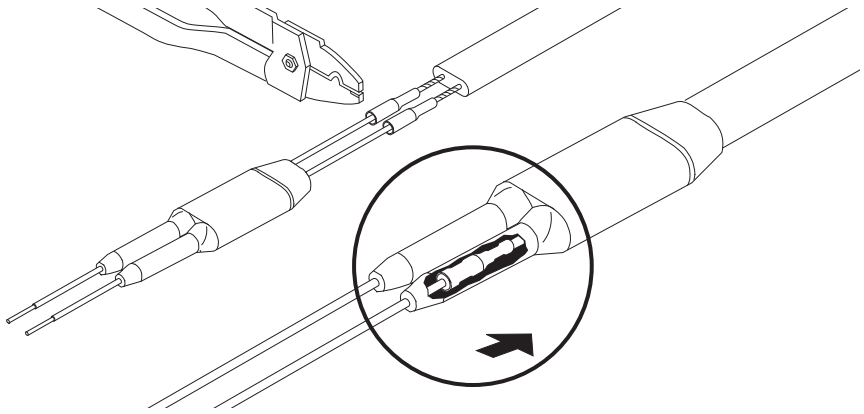
Heating Cable for CSA Only	
LBTV-CT	K
5BTV1, 2-CT	B
8BTV1, 2-CT	C
10BTV1, 2-CT	E
10QTVR1, 2-CT	C
20QTVR1, 2-CT	E
All XTV-CT	R

*8HXTV-CT and 18HXTV-CT are obsolete products. Call nVent to determine "N" grommet availability for these products.

11. Following the test method outlined in Section 5.10.2 (and illustrated in Figure 1 of that section), perform an insulation resistance test on the heating cable. Record these readings in the "Insulation Resistance Testing" section of the FM Required Division 1 Installation Record, which is Appendix F of this manual.

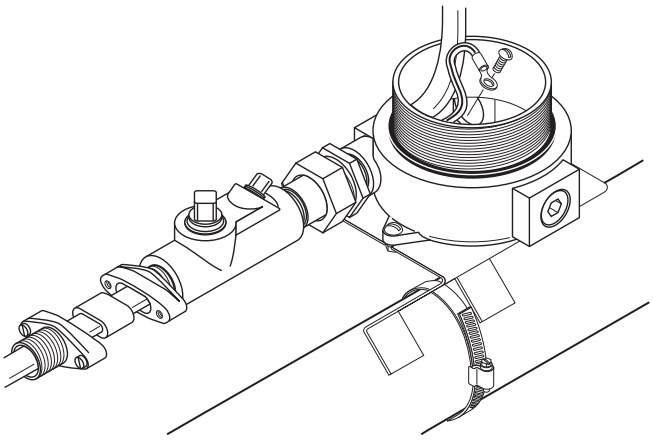


12. Slide a cold lead into each leg of the core sealer and out the other end. Strip cold lead ends to dimension shown.

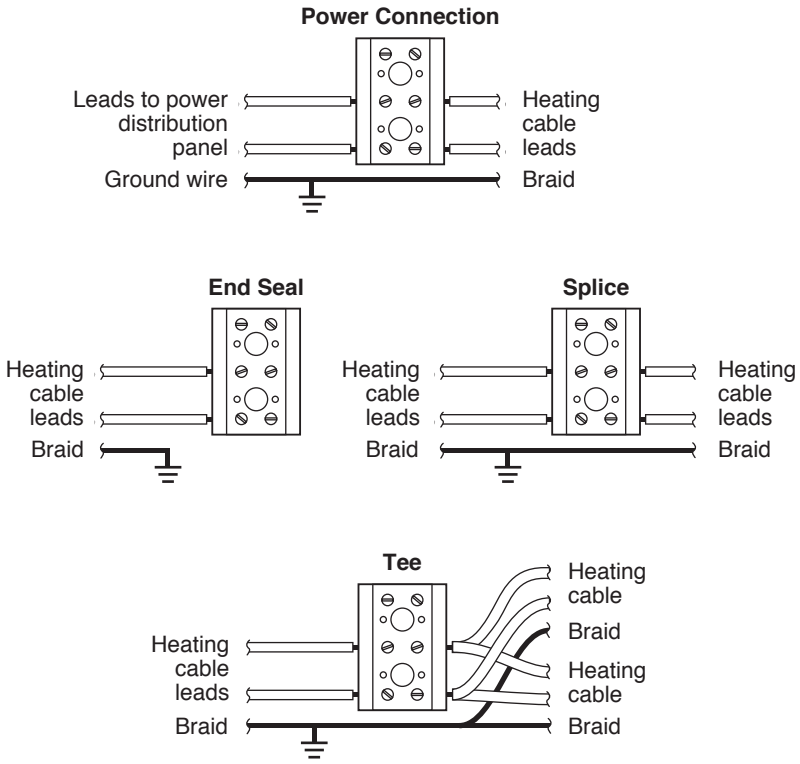


13. Crimp cold leads to heating cable bus wires, using a Burndy MR8-9Q crimp tool. Use large crimp opening for the cold lead and smaller opening for the bus wire. Slide the core sealer over crimped connectors until it bottoms out on heating cable.

Heat-Tracing Systems for Hazardous Division 1 Locations



14. Fasten terminal to ground lug in junction box. Ground wire for heating cable braid must be connected to junction box ground lug.



15. Make connections to terminal block. Do not connect ground wire or braid to terminal block. (Terminal block is installed “floating” in the junction box.)

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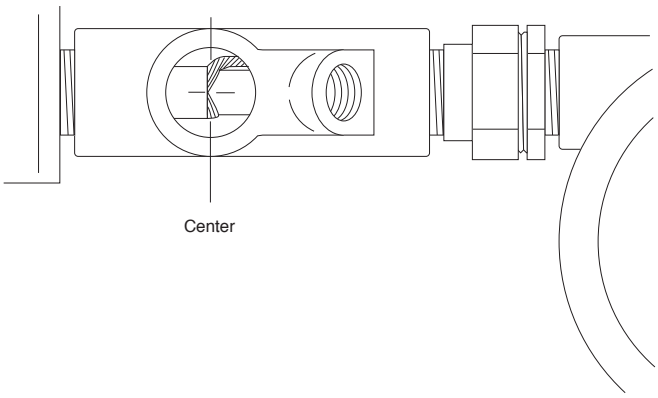
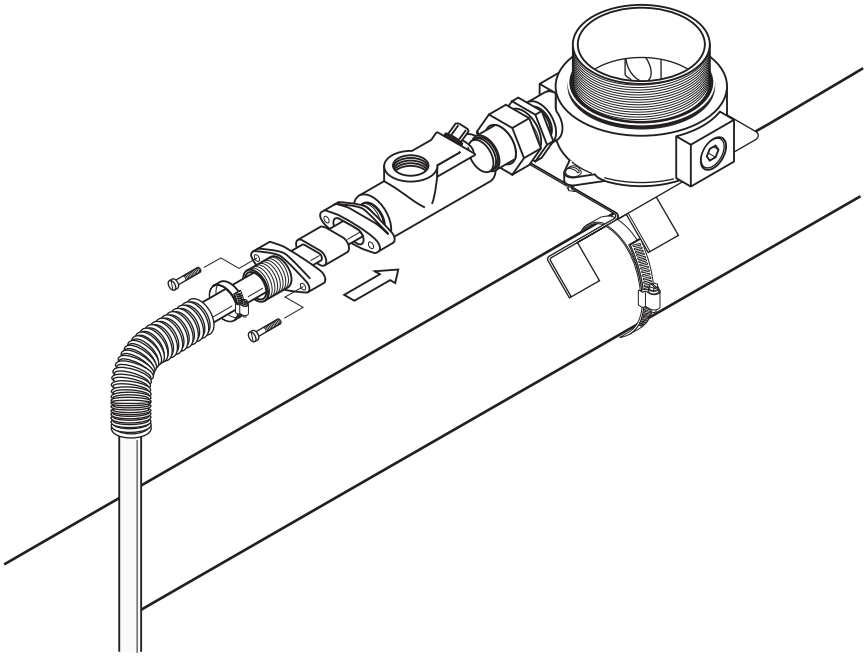
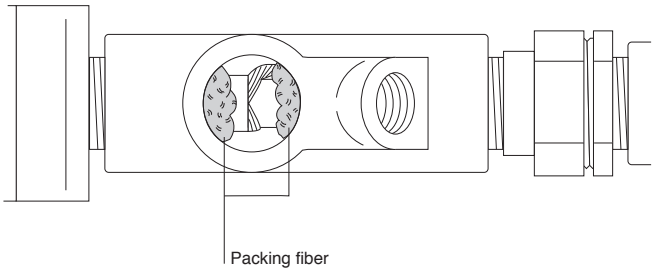


16. Remove large plug from sealing fitting. Pull heating cable back through component hardware, centering end of outer jacket in sealing fitting opening. Be sure no yellow/green tubing extends into seal fitting.



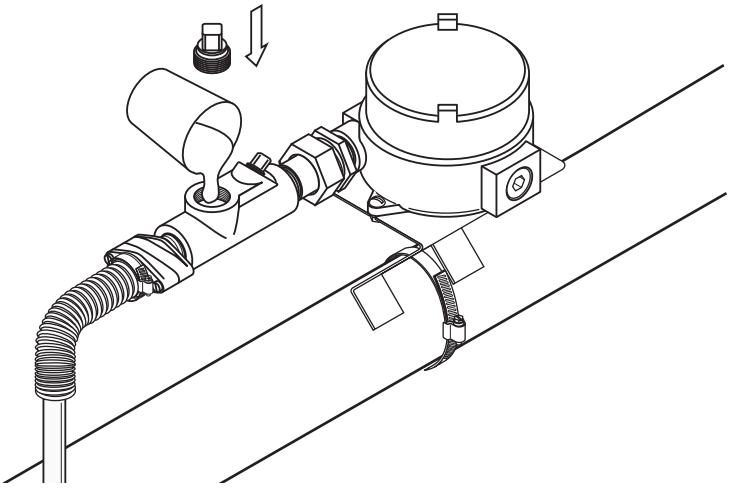
17. Position grommet in cavity. Install screws in compression gland and tighten firmly. **Be careful not to change position of heating cable in sealing fitting.** Screw corrugated tubing onto end of compression gland. Install tubing clamp.

Heat-Tracing Systems for Hazardous Division 1 Locations



18. Using packing fiber, pack around heating cable, forming a dam to prevent sealing compound from leaking.

Note: Make sure the insulation resistance testing is completed prior to pouring seals. Refer to Step 11 and Section 5.10.2, Figure 1.



19. Mix sealing compound according to manufacturer's recommendation on container. Sealing mixture should be a pourable paste. Pour into sealing fitting. Install fitting plug. Stow wires and terminal block in junction box and install cover.

5.7 Thermal Insulation Requirements

5.7.1 Preinsulation Checks

Visually inspect the heating cable and components for correct installation and damage. Refer to Section 6.2, Troubleshooting, for a summary of symptoms, possible causes, and recommended corrections.

5.7.2 Insulation Installation Hints

Correct temperature maintenance requires dry thermal insulation, properly installed.

Check insulation type and thickness against the design specification, or consult nVent product literature for insulation data.

Check that all pipework—including fittings, wall penetrations, and other areas—has been completely insulated.

Insulate as soon as possible after tracing to prevent heating cable damage.

5.7.3 Marking

Mark the location of heating cable components on outside of insulation.

Install “Electric Traced” labels along piping at 10-foot (3-meter) intervals on alternate sides.

5.8 Thermostat Controls

Follow the installation instructions supplied with the thermostat. Use the proper wiring diagram for the heating cable layout and control method desired. Wire the thermostat using the normally closed (NC) terminals so that the contacts close with falling temperature.

Heat-Tracing Systems for Hazardous Division 1 Locations

5.9 Power Supply and Electrical Protection Requirements

5.9.1 Voltage Rating

Make sure that the heating cable voltage rating is suitable for the available service voltage.

5.9.2 Electrical Loading

Size overcurrent protective devices according to the design specification or applicable nVent product literature. If devices other than those specifically identified are used, consult the factory for the appropriate sizing information.

5.9.3 Ground-Fault Protection

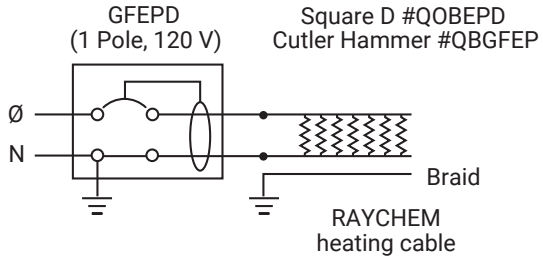
Use ground-fault equipment protection devices with a 30-mA trip level.

5.9.4 GFEPD Wiring Schematics

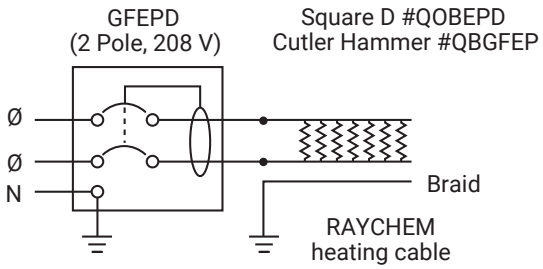
⚠ **WARNING:** To minimize the danger of fire from sustained electrical arcing if the heating cable is damaged or improperly installed, and to comply with nVent requirements, agency certifications, and national electrical codes, ground-fault equipment protection must be used on each heating cable branch circuit. Arcing may not be stopped by conventional circuit breakers.

⚠ **WARNING:** Disconnect all power before making connections to the heating cable.

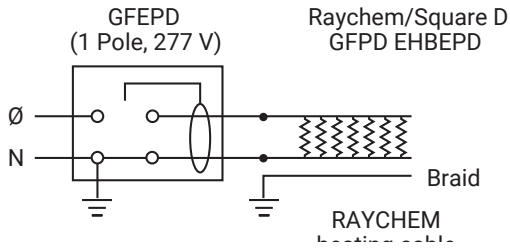
120 Vac Schematic



208/240 Vac Schematic



277 Vac Schematic



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5.10 Heating Cable Testing

5.10.1 Insulation Resistance Testing

Insulation resistance testing with a megohmmeter should be conducted before installation, before thermal insulation, after insulation, before powering the circuits, and as part of the periodic system inspection routine. A 2500 Vdc tester should be used.

First measure the resistance between the heating cable bus wires and the braid (Test A), then measure the resistance between the braid and the metal pipe (Test B).

Insulation resistance testing is a reliable indicator of the electrical integrity of the system when all the installation instructions are properly followed.

5.10.2 Test Method

⚠ WARNING: Fire hazard.
Megohmmeter test can produce sparks. Be sure there are no flammable vapors in the area before performing this test.

Connect the test as shown below:

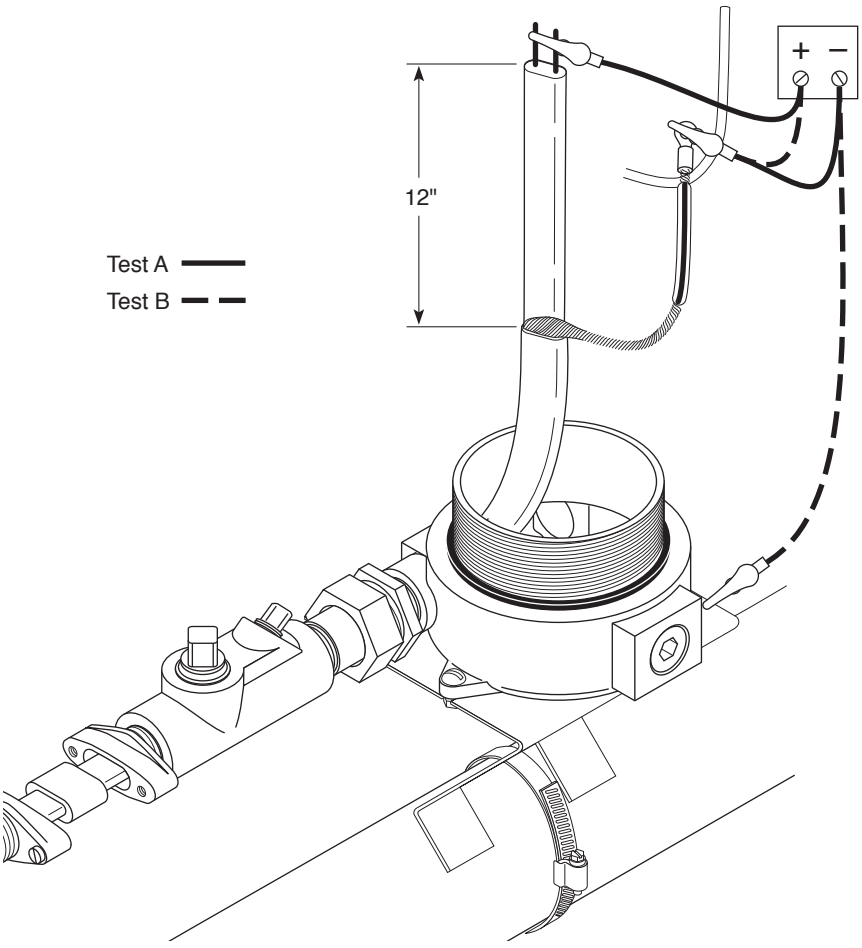

FIGURE 1. INSULATION RESISTANCE TEST

Important: Be sure to isolate the braid from ground before performing Test B. To perform Test B after sealing compound is poured into sealing fitting (as braid may contact sealing fitting or junction box), see Figure 2, Postinsulation Resistance Test, on the next page.

Tests A and B should each be performed at three voltages—500, 1000, and 2500 Vdc. If there is variation between these readings, refer to Section 6.2, Troubleshooting. Record the A and B insulation resistance values at 2500 Vdc in Appendix F.

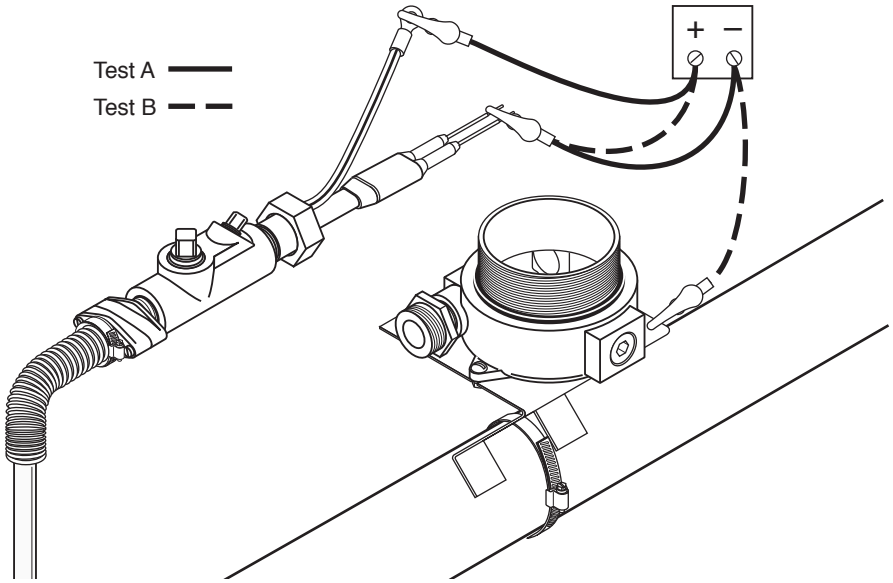

Figure 2. Postinsulation Resistance Test

Disconnect braid and bus wires from terminals, disconnect union and pull cable out of the junction box, isolate the assembly from ground and conduit, and test as shown.

When reinstalling assembly in the junction box, be sure core sealer is fully installed over the heating cable.

5.10.3 Insulation Resistance Criteria

A clean, dry, properly installed circuit should measure thousands of megohms, regardless of heating cable length or measuring voltage (0–2500 Vdc). The following criteria are provided to assist in determining acceptability of an installation where optimum conditions may not apply.

- All insulation resistance values should be greater than or equal to 1000 megohms.
- Insulation resistance values from Test A, for any particular circuit, should not vary more than 25% as a function of measuring voltage.
- Insulation resistance values from Test B, for any particular circuit, should not vary more than 25% as a function of measuring voltage.

If any of the above conditions is not met, consult Section 6.2, Troubleshooting, for further details.

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OPERATION, MAINTENANCE, AND REPAIR

6.1 Operation and Inspection

6.1.1 Heating Cable Operation

Temperature exposure must not exceed that specified in RAYCHEM product literature. Exceeding those limitations will shorten product service life.

Pipe insulation must be complete and dry to maintain the correct temperature.

6.1.2 Periodic Inspection

⚠ **WARNING:** Damaged heating cable or components can cause electrical shock, arcing, and fire. Do not attempt to repair or energize damaged cable. Remove damaged sections at once and replace them with a new length using the appropriate RAYCHEM splice kit.

Visual inspection: Heating cable and pipe insulation should be checked periodically to make sure that no physical damage has occurred.

Insulation resistance testing: The system should be tested once a year in accordance with the instructions for the Postinsulation Resistance Test in Section 5.10.2, Figure 2.

Functional testing of electrical protection and temperature control systems should be done as necessary.

The Inspection Record (Appendix G) should be filled out during maintenance of each circuit in the system.

6.1.3 Piping System Repair and Maintenance

During pipe repair work, disconnect heating cable circuits and protect heating cables from mechanical or thermal damage.

Check heating cable installation after pipe repairs and restore thermal insulation following the recommendations in Section 5.7. Ensure that electrical protection devices are working properly.

6.1.4 Heating Cable Damage

Do not repair damaged heating cable. Remove entire damaged section and splice in a new length, using RAYCHEM HAK-C-100 kits.

Refer to Section 6.2, Troubleshooting, for a summary of symptoms, possible causes, and recommended corrections.

6.2 Troubleshooting

Symptom	Probable Causes	Corrective Action
Low or inconsistent insulation resistance	Nicks or cuts in the heating cable.	Check power, splice, tee, and end connections for cuts, improper stripping distances, and signs of moisture. If heating cable is not yet insulated, visually inspect the entire length for damage, especially at elbows and flanges and around valves. If the system is insulated, disconnect heating cable section between power kits, splices, etc., and test again to isolate damaged section.
	Short between the braid and heating cable core or the braid and pipe.	
	Arcing due to damaged heating cable insulation.	Replace damaged heating cable sections and restrip any improper or damaged connections.
	Moisture present in the components.	If moisture is present, dry out the connections and retest. Be sure all conduit entries are sealed, and that condensate in conduit cannot enter power connection boxes. If heating cable core or bus wires are exposed to large quantities of water, replace the heating cable. (Drying the heating cable is not sufficient, as the power output of the heating cable can be significantly reduced.)
	Test leads touching the junction box.	Clear the test leads from junction box and restart.
	High pipe temperature may cause low IR reading.	Retest at ambient, if necessary.
	Reference tests:	**Insulation Resistance Test, Visual Inspection**

Symptom	Probable Causes	Corrective Action
Circuit breaker trips	Circuit breaker is undersized.	Recheck the design for startup temperature and current loads. Do not exceed the maximum circuit length for heating cable used. Check to see if existing power wire sizing is compatible with circuit breaker. Replace the circuit breaker if defective or improperly sized. Visually inspect the power connections, splices, and end seals for proper installation; correct as necessary.
	Start-up at too low a temperature. Connections and/or splices are shorting out.	
	Physical damage to heating cable is causing a direct short.	Check for visual indications of damage around the valves, pump, and any area where there may have been maintenance work. Look for crushed or damaged insulation lagging along the pipe. Replace damaged sections of heating cable.
	Bus wires are connected at the end.	Check the end seal to ensure that bus wires are properly terminated per installation instructions. If a dead short is found, the heating cable may have been permanently damaged by excessive current and may need to be replaced.
	Nick or cut exists in heating cable or power feed wire with moisture present or moisture in connections.	Replace the heating cable, as necessary. Dry out and reseal the connections and splices. Using a megohmmeter, retest insulation resistance.
	GFPD is undersized (5 mA used instead of 30 mA) or miswired.	Replace undersized GFPD with 30 mA GFPD. Check the GFPD wiring instructions.
	Reference tests:	**Insulation Resistance Test, Fault Location Test, Visual Inspection**

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Operation, Maintenance, and Repair

OPERATION, MAINTENANCE, AND REPAIR

Symptom	Probable Causes	Corrective Action
Low pipe temperature	Insulation is wet, or missing.	Remove wet insulation and replace with dry insulation, and secure it with proper weatherproofing.
	Insufficient heating cable was used on valves, supports, and other heat sinks.	Splice in additional heating cable but do not exceed maximum circuit length.
	Thermostat was set incorrectly.	Reset the thermostat.
	Improper thermal design used.	Contact your nVent representative to confirm the design and modify as recommended.
	Improper voltage applied.	
	Thermocouple is not in contact with pipe.	Reinstall the thermocouple on the pipe.
	Reference tests:	**Power Check, Visual Inspection**

Symptom	Probable Causes	Corrective Action
Low or no power output	Low or no input voltage applied.	Repair the electrical supply lines and equipment.
	The circuit is shorter than the design shows, due to splices or tees not being connected, or the heating cable having been severed.	Check the routing and length of heating cable (use "as built" drawings to reference actual pipe layout).
		Connect all splices or tees. Locate and replace any damaged heating cables. Then recheck the power output.
	Improper component connection causing a high-resistance connection.	Check for loose wiring connections and rewire if necessary.
	Control thermostat is wired in normally open position.	Rewire the thermostat in the normally closed position.
	Pipe is at an elevated temperature.	Check the pipe temperature. Verify heater selection. Check the power output of the heating cable per the design vs. actual. Reduce pipe temperature if possible or contact your nVent representative to confirm design.
	The heating cable has been exposed to excessive temperature, moisture or chemicals.	Replace damaged heating cable. Check the pipe temperature. Check the power output of heating cable.
	Reference tests:	**Power Check, Fault Location Test, Visual Inspection**

Note: The power output is temperature-sensitive and requires the following special procedure to determine its value:

1. Check the pipe temperature under the thermal insulation at several locations.
2. Power the heating cable and allow it to stabilize for 10 minutes, then measure current and voltage at the junction box.
3. Calculate the power (watts/ft) of the heating cable by multiplying the current by the input voltage and dividing by the actual circuit length.

$$\frac{\text{Current (amps) x Volts (Vac)}}{\text{Length (feet)}} = \text{Power (W/ft)}$$

4. See the Thermal Output Ratings Graphs on pages 10 and 11 for expected power output at measured temperature.

Heat-Tracing Systems for Hazardous Division 1 Locations

ANSWERS TO FREQUENTLY ASKED QUESTIONS

What is required to get FM approval?

- Field information required for FM must be filled out (see Appendix E) and the information approved by nVent technical support.
- The approved FM CID1 heating cable must not exceed the T-rating for the area, or the heating cable's maximum sheath temperature must not exceed auto-ignition temperature (AIT) for the hazardous materials in the area.
- Postinstallation, the FM-required CID1 Installation Record (Appendix F) must be completed and sent to nVent's Customer Service Center, where it will be kept on file.

Why is the Field Information form required?

This form is required by FM as part of their approval. It has two purposes:

1. It identifies the company and the contact person responsible for the hazardous area heat-tracing design.
2. It identifies either the T-rating for the area or the lowest AIT of the hazardous substances in the area. This information is used by nVent to verify that the RAYCHEM heating cable meets the area requirements.

Note: The customer must identify the T-rating for the area. If this information is not available, then the lowest AIT for the area must be identified. This section must be filled out by the person designing the system and/or the person most familiar with the hazardous location. nVent cannot fill this section in because we cannot make any assumptions about the area being designed.

What if I don't know the AIT?

If the T-rating is not known, then identifying the lowest AIT in the area should be done by contacting the safety manager or project expert. Identifying the correct AIT is critical to ensure the safest design, and this information is required before nVent can process the order. nVent cannot make any assumptions about the area; therefore, this information must be obtained from the area expert.

What is the difference between the flash point and the AIT?

The flash point of a liquid is the minimum temperature at which the liquid gives off sufficient vapor to form an ignitable mixture with air near the surface of the liquid or within the test vessel used. "Ignitable mixture" means a mixture that is within the flammable range (between the upper and lower limits), and thus is capable of propagation of flame away from the source of ignition. The AIT of a substance is the minimum temperature required to cause self-sustained combustion, independently of a flame or heated element.

As an example of the difference between the flash point temperature and the AIT, gasoline is listed in NFPA 497, Recommended Practice for the Classification of Flammable Liquids, Gases, and Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas, as having a flash point of –46°C and an AIT of 280°C. This means that gasoline will form vapors at temperatures above –46°C. These vapors could burn if exposed to a flame. However, only if the temperature exceeds 280°C will those vapors self-ignite (without being exposed to a flame).

If the heat tracing goes through a CID1 area but is terminated in an ordinary area, do you need to use hazardous area components?

If both ends of the heating cable are terminated in an ordinary area, then RAYCHEM ordinary area industrial components can be used with the approved CID1 heating cable, subject to acceptance by the authority having approval jurisdiction. This statement is documented in the new CID1 design and installation guide in Section 1.4, page 6.

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Answers to frequently asked questions

ANSWERS TO FREQUENTLY ASKED QUESTIONS

What happens if the end user does not fill out the FM-required CID1 Installation Record (Appendix F) after installing the product?

The customer will not have an approved FM system. This form must be filled out and returned to the nVent Customer Service Center to complete the approval process.

In North America, we are starting to hear about "Zone" approvals. How do these approvals relate to CID1 applications?

The NEC declares that cables certified for use in CID1 areas may be used in Zone 1 areas, and cables certified for use in CID2 areas may be used in Zone 2 areas. However, cables with Zone 1 or Zone 2 approvals are not approved for CID1 or CID2 areas, respectively.

The reason for this difference is that CID1 approvals cover hazardous areas not included in Zone 1 areas, so Zone 1-approved products may not necessarily be tested for all CID1 areas.

What indicator light solution is available for CID1 areas?

The E-100-L is not approved for CID1 areas, and currently nVent does not offer an end-of-line indicator light for these areas.

C. Installation

In the CID1 design guide, there is a new section describing the minimum bend radius. Why is the minimum bend radius important?

It is important not to bend the heating cables less than one inch in the in-plane direction or less than half an inch in the out-of-plane direction, to prevent bus wire damage.

Which products can be used on plastic pipes?

HBTV is the product that should be used on all types of standard plastic pipes. Typically, the maximum exposure temperature for PVC pipe (schedule 40) is 150°F. In some cases, plastic pipes can withstand higher temperatures, which would sometimes allow HQTV to be used. TraceCalc Pro can be used to see if a heating cable is appropriate to be used on a particular pipe.

D. Operation and Maintenance

What is the warranty?

The standard nVent Industrial Heat Tracing warranty. An extended warranty is offered on these products as well. A warranty package can be ordered, free of charge, through the nVent Customer Service Center.

How can I get more information?

For answers to questions not listed here, please contact the nVent Customer Service Center at (800) 361-4525 in the U.S. and (800) 988-5171 in Canada.

E. Logistics

Our policy on stocking these products has changed. These products can be stocked by our channel partners; however, they then must accept responsibility for getting the Field Information and the Inspection Records completed and returned to the nVent Customer Service Center. The rep stocking the product must verify the design requirements.

Heat-Tracing Systems for Hazardous Division 1 Locations

APPENDIX A: SYSTEM APPROVALS

FM Approval

RAYCHEM HBTV-CT, HQTV-CT and HXTV-CT heating cables have the following approvals when used with an HAK-C-100 connection kit, and an approved junction box.

Factory Mutual

Class I, Division 1, Groups B, C, and D
Class II, Division 1, Groups E, F, and G
Class III, Division 1

Note:
HXTV-CT heating cables are FM-approved for use in Class II and Class III areas only if the individual system is specially engineered by nVent.

CSA Certification

RAYCHEM BTV-CT, QTVR-CT and XTV-CT heating cables are CSA Certified when used with an HAK-C-100 connection kit and an approved junction box.

Class I, Division 1, Groups B, C, and D
Class II, Division 1, Groups E, F, and G
Class III, Division 1

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Appendix B: Alternate Voltage Adjustment Factors

APPENDIX B: ALTERNATE VOLTAGE ADJUSTMENT FACTORS

RAYCHEM heating cables can be used with nominal variations (± 5%) in service voltages without causing significant changes in power output.

The table below shows the effect of alternate voltages on 240 V RAYCHEM heating cables as compared to the nominal power output rating at 240 V. **Note:** When using circuit length adjustment factors that are greater than 1.00, do not exceed the maximum circuit lengths shown below.

Heating cable Operating voltage: 208 Volts	Thermal output adjust factor	Circuit length adjustment factor	Maximum heating cable circuit length
5HBTV2-CT, 5BTV2-CT	0.85	0.99	500 feet
8HBTV2-CT, 8BTV2-CT	0.89	0.93	385 feet
10HBTV2-CT, 10BTV2-CT	0.89	0.93	330 feet
12HQTV2-CT, 10QTVR2-CT	0.85	0.98	365 feet
20HQTV2-CT, 20QTVR2-CT	0.90	0.92	350 feet
5HXTV2-CT, 5XTV2-CT-T3	0.84	1.00	720 feet
10HXTV2-CT, 10XTV2-CT-T3	0.83	0.98	510 feet
15HXTV2-CT, 15XTV2-CT-T3	0.85	0.97	415 feet
20HXTV2-CT, 20XTV2-CT-T2	0.88	0.97	350 feet
Operating voltage: 277 Volts			
5HBTV2-CT, 5BTV2-CT	1.12	1.07	585 feet
8HBTV2-CT, 8BTV2-CT	1.08	1.08	465 feet
10HBTV2-CT, 10BTV2-CT	1.08	1.05	395 feet
12HQTV2-CT, 10QTVR2-CT	1.18	1.06	410 feet
20HQTV2-CT, 20QTVR2-CT	1.07	1.06	430 feet
5HXTV2-CT, 5XTV2-CT-T3	1.18	1.03	750 feet
10HXTV2-CT, 10XTV2-CT-T3	1.17	1.06	575 feet
15HXTV2-CT, 15XTV2-CT-T3	1.13	1.08	475 feet
20HXTV2-CT, 20XTV2-CT-T2	1.10	1.11	440 feet

Example:

Adjust the power output of 8HBTV2-CT for a service voltage of 208 volts:

The power output of 8HBTV2-CT at 40°F is 8.8 watts/ft. From the table above, the power output of 8HBTV2-CT, if powered at 208 volts, is 89% of its 240-volt rating.

Adjusted power output:
8.8 W/ft x 89% = 7.8 w/ft at 208 volts

To find the maximum heating cable circuit length for 8HBTV2-CT if started at 50°F and powered at 208 volts:

From the circuit breaker selection table, (Table 3), 8HBTV2-CT, if started at 50°F on a 15-amp circuit breaker with a service voltage of 240 volts, has a maximum circuit length of 200 feet. From the table above, the circuit length adjustment factor for 8HBTV2-CT powered at 208 volts is 0.93.

Adjusted maximum circuit length:

200 x 0.93 = 186 ft at 208 volts

A 15-amp breaker is acceptable.

APPENDIX C: HEAT-SHRINK CORE SEALER INSTALLATION

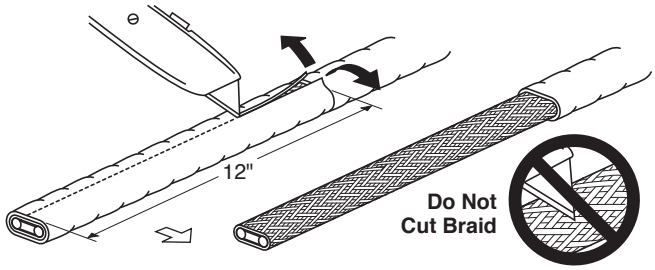
A. Heat-Shrink Kit Description

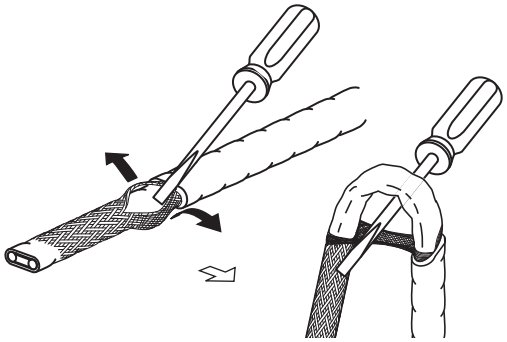
As part of the nVent RAYCHEM HAK-C-100 kit, an optional heat-shrink core sealer kit is provided for those customers wanting this option. The heat-shrink core sealer kit contains:

- Two 6-inch black heat-shrinkable tubes
- One 1-inch yellow heat-shrinkable tube

B. Installation Instructions

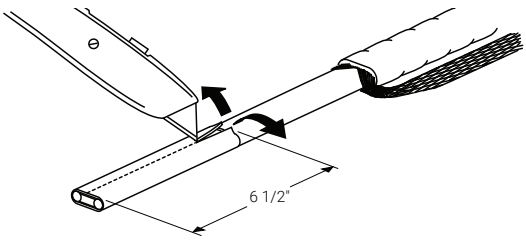
Follow the Section 5.6 instructions, but replace steps 5 through 9 with the following heat-shrink core sealer instructions.





5. Score around outer heating cable jacket 12 inches from end. Score from this point to end of heating cable. Remove outer jacket, being careful not to damage braid.

   Using a small screwdriver as an aid, spread braid at base to expose inner jacket of heating cable. Bend heating cable at base of braid while pushing it through and working insulated heating cable out. Pull heating cable completely out of braid. Twist braid to form a tight pigtail.



6. Score around inner heating cable jacket 6 1/2 inches from end. Score from this point to end of heating cable. Flex along score lines and remove the inner jacket to expose polymer core or fibers. Slip yellow/green heat-shrink tube over braid to prevent stray braid wires from touching bus wires.

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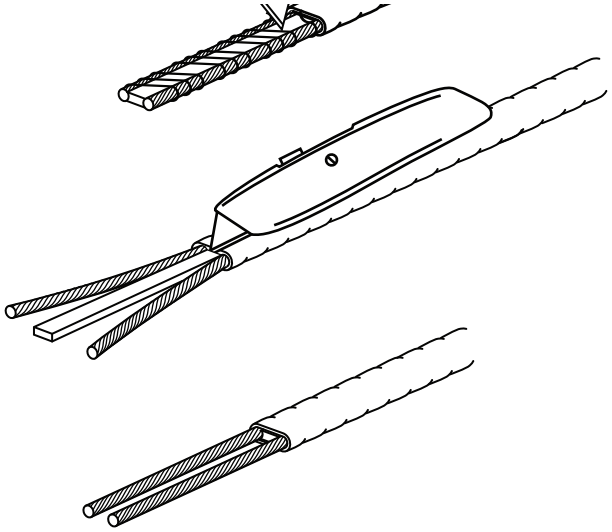
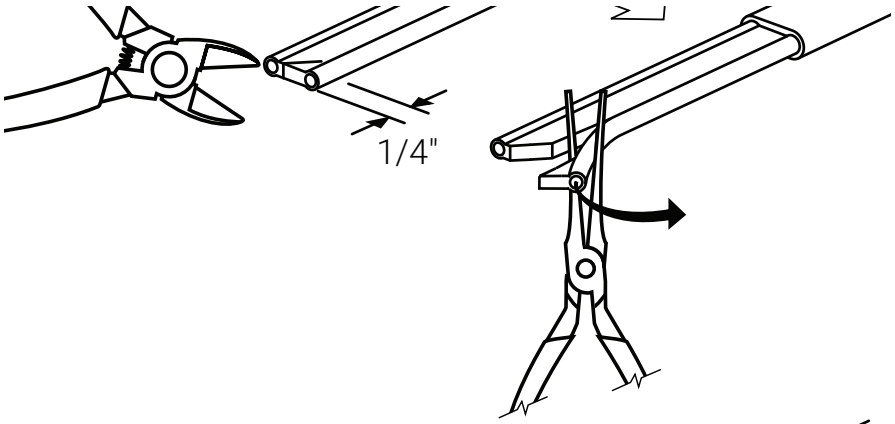
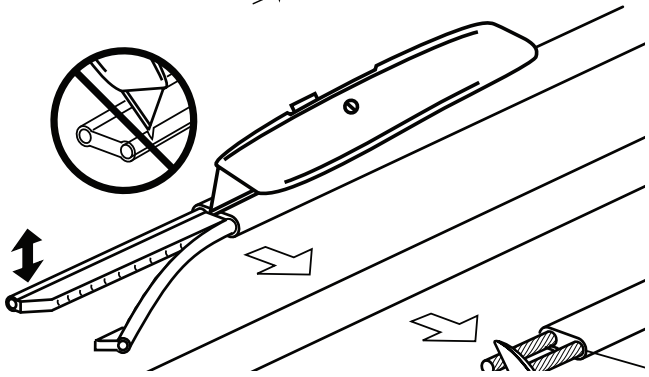
Appendix C: Heat-Shrink Core Sealer Installation

APPENDIX C: HEAT-SHRINK CORE SEALER INSTALLATION

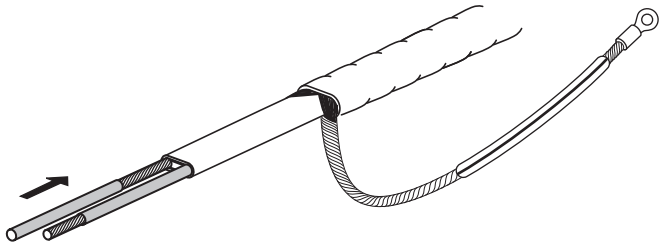


7a. For the fiber heating cables, cut and remove all fiber strands. Score and remove center spacer. Clean bus wires.

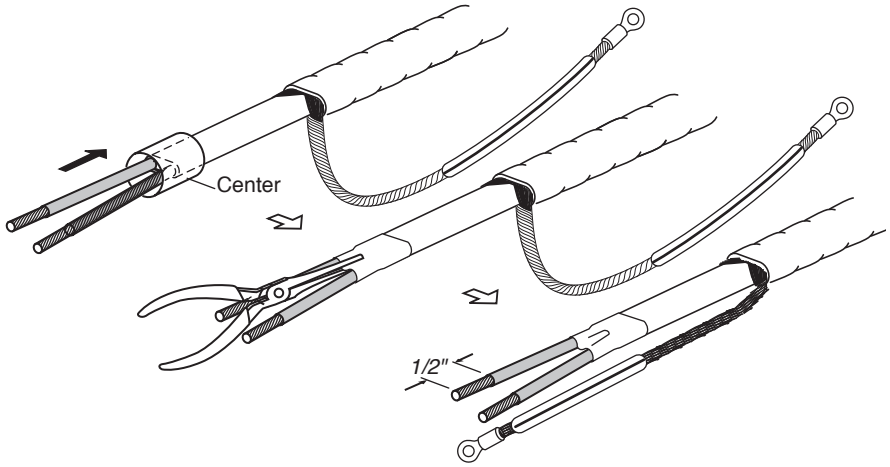




7b. For the solid core heating cables, notch core. Twist back and peel bus wire from core. Score core between bus wires at inner jacket. Bend and snap core. Peel core free from bus wire. Clean bus wires.



8. Slide on black heat-shrinkable tubes. Use heat gun or mini-torch with soft yellow flame to gently heat tubes until they shrink. Because heat guns or mini-torches can cause fire or explosion in hazardous areas, be sure there are no flammable materials or vapors in the area. Twist braid to form a tight pigtail. Slip yellow/green heat-shrink tube over braid to prevent stray braid wires from touching bus wires. Crimp ring terminal to braid pigtail using a Panduit CT-100 crimp tool. Trim braid if needed.



9. Center clear yellow tube over end of inner jacket. Heat tube until it shrinks and adhesive flows out ends. While still hot, pinch between bus wires and hold for 5 seconds. Trim wire ends to 1/2 inch.

Appendix C: Heat-Shrink Core Sealer Installation

APPENDIX D: FIELD INFORMATION REQUIRED FOR FM APPROVAL

APPENDIX D: FIELD INFORMATION REQUIRED FOR FM APPROVAL

FM Required Installation Record for Class I, Division 1, Hazardous Locations

To complete the FM approval process, this complete form must be returned to the nVent Customer Service Center (fax number (800) 527-5703)

Company name _____ **Purchase order no.** _____

Circuit ID no. _____ **Ref. drawing(s)** _____

Area _____

Autoignition temp. (AIT): _____ Group classification: _____

Heater circuit

Heater type: _____

Supply voltage: _____ Circuit length: _____

Maximum pipe temp: _____ Temp ID (T-rating) _____

Components

Power connection _____ Splice: _____

Tee End seal: _____

Ground-fault equipment

Make and model: _____ Device trip level: _____

Installation instructions

Correct components per manufacturer's specification: _____

Seal fittings opened and inspected (properly poured): _____

Ground-leakage device tested: _____

Insulation resistance testing

Use 2500 Vcd for Self-Regulating and Power-Limiting cables

Instrument used: _____ Calibration date:

As measured on the pipe before insulation installed*	**Test value**	**Date**	**Initials**
Insulation resistance between conductor and braid (Test A)			
Insulation resistance between braid and pipe (Test B)			
As measured after insulation installed*	**Test value**	**Date**	**Initials**
Insulation resistance between conductor and braid (Test A)			
Insulation resistance between braid and pipe (Test B)			

* Minimum insulation resistance must be 1000 MΩ

Circuit ready to commission

_____ _____

Prepared by Company Date

_____ _____

Approved by Company Date

Heat-Tracing Systems for Hazardous Division 1 Locations

APPENDIX E: INSPECTION RECORD

For freeze protection circuits, perform these checks before winter arrives.
For temperature maintenance circuits, perform these checks at least twice a year.

Panel ID number

Circuit ID number

Heating cable type

Circuit length

Date

Visual inspection for damaged, missing, or wet insulation and cladding.	Initial								
Visual inspection for overheating, corrosion, moisture, etc. in connections.	Initial								
Proper electrical ground and connection to heating cable. Connections and heating cable are insulated from connection box.	Initial								
Entire system energized and functionality of GFEPDs checked.	Initial								
Thermostat checked for moisture, corrosion, set point, switch operation. Capillary is protected.	Initial								
Megohmmeter tests performed at power connection. Both bus wires disconnected.	Instrument used:								
	Last calibrated								
	500 Vdc reading								
	1000 Vdc reading								
	2500 Vdc reading								
	Initial								
Circuit voltage at power connection.	Reading								
Circuit amperage.	Reading								
Pipe temperature at time amps were measured.	Reading								
Watts/feet	Initial								
Volts x amps/feet									
All connections, boxes, thermostats have been resealed.	Initial								
End seals, covered splices, and tees are marked on insulation cladding.	Initial								

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Appendix C: Heat-Shrink Core Sealer Installation

APPENDIX F: BTV HEATING CABLE SELECTION FOR INSULATED PLASTIC PIPES

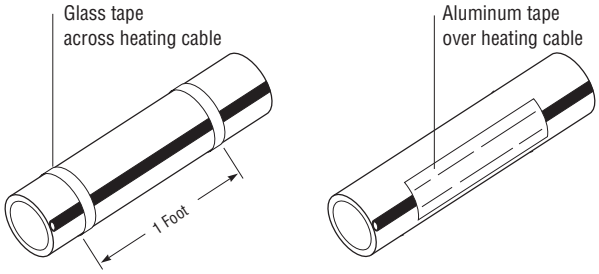
HBTV-CT and BTV-CT heating cables are ideal for heat-tracing plastic pipes. However, increased resistance to heat transfer from the heating cable to the plastic pipe necessitates compensation of its thermal output. Aluminum tape may be used to increase the thermal output of HBTV and BTV heating cables on plastic pipes.

The thermal output adjustment factors for typical applications are shown below.

Thermal Output Adjustment Factors (pipe wall thickness 0.250" or less*)

Heating cable	Glass tape across heating cable	Aluminum tape over heating cable
5HBTV1-CT, 5BTV1-CT	0.55	0.75
5HXTV2-CT, 5BTV2-CT	0.50	0.75
8HBTV1-CT, 8BTV1-CT	0.50	0.70
8HBTV2-CT, 8BTV2-CT	0.45	0.65
10HBTV1-CT, 10BTV1-CT	0.40	0.60
10HBTV2-CT, 10BTV2-CT	0.45	0.70

*Equivalent to 3 1/2" schedule 40 PVC pipe. For greater pipe wall thickness, consult the factory or your nVent representative.



APPENDIX G: EFFECT OF ALUMINUM TAPE ON RAYCHEM HEATING CABLE

Aluminum tape (AT-180) can be used with RAYCHEM heating cable with nominal variations in power output. The chart below shows the multiplier for power output and circuit length for both 120-volt and 240-volt RAYCHEM heating cable as compared to the nominal ratings, when installed on carbon steel pipe.

Note: When using circuit length adjustment factors, do not exceed the maximum circuit lengths shown below.

Auto-Trace heating cables powered at	120 Volts			240 Volts		
Heating cable	Power output factor	Circuit length multiplier	Maximum heating cable circuit length	Power output factor	Circuit length multiplier	Maximum heating cable circuit length
5HBTV-CT, 5BTV-CT	1.2	0.83	225 feet	1.2	0.83	450 feet
8HBTV-CT, 8BTV-CT	1.2	0.77	160 feet	1.3	0.77	320 feet
10HBTV-CT, 10BTV-CT	1.3	0.77	135 feet	1.2	0.83	300 feet
12HQTV-CT, 10QTV-CT	1.15	0.83	130 feet	1.15	0.83	325 feet
20HQTV-CT, 20QTV-CT	1.25	0.77	150 feet	1.25	0.77	300 feet
5HXTV-CT, 5XTV-CT	1.15	0.83	320 feet	1.15	0.83	635 feet
10HXTV-CT, 10XTV-CT	1.15	0.83	225 feet	1.15	0.83	450 feet
15HXTV-CT, 15XTV-CT	1.15	0.83	180 feet	1.15	0.83	370 feet
20HXTV-CT, 20XTV-CT	1.15	0.83	155 feet	1.15	0.83	320 feet

Heat-Tracing Systems for Hazardous Division 1 Locations

APPENDIX H: HAZARDOUS GASES AND VAPORS

The following pages contain excerpts from the National Fire Protection Association publication NFPA 497M "Classification of Gases, Vapors, and Dusts for Electrical Equipment in Hazardous (Classified) Locations 1994 Edition." The list includes the ignition temperatures and group classifications for Class I gases. Class II dusts and Class III fibers and filings are not listed.

Note that considerable skill and judgment must be applied when deciding to what degree an area contains hazardous concentrations of vapors, combustible dust, or easily ignitable fibers and filings. Many factors—such as temperature, barometric pressure, quantity of release, humidity, ventilation, and distance from the vapor source—must be considered. When information on every factor concerned is properly evaluated, a consistent classification of the selection and location of electrical equipment can be developed.

For a complete list of properties of flammable liquids, gases, and solids, see NFPA 497M, "Classification of Gases, Vapors, and Dusts for Electrical Equipment in Hazardous (Classified) Locations 1994 Edition."

Group Classification and Auto-ignition Temperature (AIT) of Selected Flammable Gases and Vapors

Material	Group	°F	°C
Acetaldehyde	C*	347	175
Acetic Acid	D*	867	464
Acetic Anhydride	D	600	316
Acetone	D*	869	465
Acetone Cyanohydrin	D	1270	688
Acetonitrile	D	975	524
Acetylene	A*	581	305
Acrolein (inhibited)	B*	455	235
Acrylic Acid	D	820	438
Acrylonitrile	D*	898	481
Allyl Alcohol	C*	713	378
Allyi Chloride	D	905	485
Ammonia	D*	928	498
n-Amyl Acetate	D	680	360
Aniline	D	1139	615
Benzene	D*	928	498
Benzyl Chloride	D	1085	585
1,3-Butadiene	B*	788	420
Butane	D*	550	288
1-Butanol	D*	650	343
2-Butanol	D*	761	405
n-Butyl Acetate	D*	790	421
iso-Butyl Acetate	D*	790	421
n-Butyl Acrylate (inhibited)	D	559	293
Butylamine	D	594	312
Butylene	D	725	385
n-Butyraldehyde	C*	425	218
n-Butyric Acid	D	830	443
Carbon Monoxide	C*	1128	609
Chlorobenzene	D	1099	593

Raychem-DG-H56075-HTSystemsForHazDiv1Loc-EN-1805

Appendix H: Hazardous Gases and Vapors

Material	Group	°F	°C
Cresol	D	1038–1110	559–599
Crotonaldehyde	C*	450	232
Cumene	D	795	424
Cyclohexane	D	473	245
Cyclohexene	D	471	244
Cyclohexanol	D	572	300
Cyclohexanone	D	473	245
Cyclopropane	D*	938	503
p-Cymene	D	817	436
n-Decanol	D	550	288
Decene	D	455	235
Diacetone Alcohol	D	1118	603
o-Dichlorobenzene	D	1198	647
1.1-Dichloroethane	D	820	438
1.2-Dichloroethylene	D	860	460
Dicyclopentadiene	C	937	503
Diethyl Benzene	D	743–842	395–450
Diethylene Glycol Monobutyl Ether	C	442	228
Diethylene Glycol Monomethyl Ether	C	465	241
Diethylamine	C*	594	312
Diethyl Ether	C*	320	160
N-N-Dimethyl Aniline	C	700	371
Di-isobutylene	D*	736	391
Di-isobutyl Ketone	D	745	396
Di-isopropylamine	C	600	316
Dimethylamine	C	752	400
Dimethyl Formamide	D	833	455
Dimethyl Sulfate	D	370	188
1.4-Dioxane	C	356	180
Dipentene	D	458	237
Di-N-propylamine	C	570	299
Dodecene	D	491	255
Epichlorohydrin	C*	772	411
Ethane	D*	882	472
Ethanol	D*	685	363
Ethyl Acetate	D*	800	427
Ethyl Acrylate (inhibited)	D*	702	372
Ethylamine	D*	725	385
Ethyl Benzene	D	810	432
Ethyl Chloride	D	966	519
Ethylene	C*	842	450
Ethylene Chlorohydrin	D	797	425
Ethylene Glycol Monobutyl Ether	C	460	238
Ethylene Glycol Monobutyl Ether Acetate	C	645	340
Ethylenediamine	D*	725	385
Ethylene Dichloride	D*	775	413
Ethylene Glycol Monoethyl Ether	C	455	235
Ethylene Glycol Monoethyl Ether Acetate	C	715	379
Ethylene Glycol Monomethyl Ether	D	545	285

Heat-Tracing Systems for Hazardous Division 1 Locations

Material	Group	°F	°C
Ethylenimine	C*	608	320
Ethylene Oxide	B*	804	429
Ethyl Formate	D	851	455
2-Ethylhexaldehyde	C	375	191
2-Ethyl Hexanol	D	448	231
2-Ethyl Hexyl Acrylate	D	485	252
Ethyl Mercaptan	C*	572	300
Formaldehyde (Gas)	B	795	429
Formic Acid (90%)	D	813	434
Fuel Oils	D	410–765	210–407
Furfural	C	600	316
Furfuryl Alcohol	C	915	490
Gasoline	D*	536–880	280–471
Heptane	D*	399	204
Heptene	D	500	260
Hexane	D*	437	225
2-Hexanone	D	795	424
Hexene	D	473	245
Hydrazine	C	74–518	23–270
Hydrogen	B*	968	520
Hydrogen Cyanide	C*	1000	538
Hydrogen Sulfide	C*	500	260
Isoamyl Acetate	D	680	360
Isobutyl Acrylate	D	800	427
Isobutyraldehyde	C	385	196
Isophorone	D	860	460
Isoprene	D*	428	220
Isopropyl Acetate	D	860	460
Isoamyi Alcohol	D	662	350
Isopropylamine	D	756	402
Isopropyl Ether	D*	830	443
Iso-octyl Aldehyde	C	387	197
Kerosene	D	410	210
Liquefied Petroleum Gas	D	761–842	405–450
Mesityl Oxide	D*	652	344
Methane	D*	999	630
Methanol	D*	725	385
Methyl Acetate	D	850	454
Methyl Acrylate	D	875	468
Methylamine	D	806	430
Methyl n-Amyl Ketone	D	740	393
Methylcyclohexane	D	482	250
Methylcyclohexanoi	D	565	296
Methyl Ether	C*	662	350
Methyl Ethyl Ketone	D*	759	404
Methyl Formal	C*	460	238
Methyl Formate	D	840	449
Methyl Isobutyl Ketone	D*	840	449
Methyl Isocyanate	D	994	534

Appendix H: Hazardous Gases and Vapors

Material	Group	°F	°C
Methyl Methacrylate	D	792	422
2-Methyl-1-Propanol	D*	780	416
2-Methyl-2-Propanol	D*	892	478
alpha-Methyl Styrene	D	1066	574
Monoethanolamine	D	770	410
Monoisopropanolamine	D	705	374.
Monomethyl Aniline	C	900	482
Monomethyl Hydrazine	C	382	194
Morpholine	C*	590	310
Naphtha (CoalTar)	D	531	277
Nitrobenzene	D	900	482
Nitroethane	C	778	414
Nitromethane	C	785	418
1-Nitropropane	C	789	421
2-Nitropropane	C*	802	428
Nonane	D	401	205
Octane	D*	403	206
Octene	D	446	230
Pentane	D*	470	243
1-Pentanol	D*	572	300
2-Pentanone	D	846	452
1-Pentene	D	527	275
Propane	D*	842	450
1-Propanol	D*	775	413
2-Propanol	D*	750	399
Propionaldehyde	C	405	207
Propionic Acid	D	870	466
Propionic Anhydride	D	545	285
n-Propyl Acetate	D	842	450
Propylene	D*	851	455
Propylene Dichloride	D	1035	557
Propylene Oxide	B*	840	449
n-Propyl Ether	C	419	215
Propyl Nitrate	B*	347	175
Pyridine	D*	900	482
Styrene	D*	914	490
Tetrahydrofuran	C*	610	321
Tetrahydronaphthalene	D	725	385
Toluene	D*	896	480
Turpentine	D	488	253
Unsymmetrical Dimethyl Hydrazine (UDMH)	C*	480	249
Valeraldehyde	C	432	222
Vinyl Acetate	D*	756	402
Vinyl Chloride	D*	882	472
Vinylidene Chloride	D	1058	570
Vinyl Toluene	t'	921	494
Xylenes	D*	867–984	464–529

* Material has been classified by test.

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